

Oceanic Shoals Commonwealth Marine Reserve survey reveals new records of xanthid crabs (Crustacea: Brachyura: Xanthidae) from northern Australia

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Abstract

Iwasa-Arai, T., McCallum, A.W. and Taylor, J. 2015. Oceanic Shoals Commonwealth Marine Reserve survey reveals new records of xanthid crabs (Crustacea: Brachyura: Xanthidae) from northern Australia. *Memoirs of Museum Victoria* 73: 1–11.

Sampling in 2012 (SOL5650 and SS2012T07) by the RV *Solander* and RV *Southern Surveyor* resulted in a small collection of decapod crustaceans, including brachyuran crabs. The surveys were undertaken on the shelf off northern Australia, including within the Oceanic Shoals Commonwealth Marine Reserve as part of the Australian Government's National Environmental Research Program Marine Biodiversity Hub. Here we report on nine species of Xanthidae collected during these surveys, including specimens from the subfamilies Actaeinae, Euxanthinae, Liomerinae and Zosiminae. Two species are reported for the first time in Australian waters (*Acteodes mutatus* (Ortmann, 1894) and *Atergatopsis granulata* A. Milne Edwards, 1865).

Keywords

Crustacea, Decapoda, Xanthidae, Timor Sea, Australia, taxonomy

The crab family Xanthidae Macleay, 1838, is one of the largest families of Brachyuran crabs in the world, comprising more than 123 genera and 570 species (De Grave *et al.*, 2009; Ah Yong *et al.*, 2011). Xanthids are the most diverse of the crab families in Australian waters represented by more than 168 species and 50 genera (Davie, 2002; Poore, 2004). Although Xanthidae share some diagnostic features such as shape of the carapace, dorsal surface, shape of anterolateral margins, cheliped and ambulatory legs, such characters are the result of convergence (Thoma *et al.*, 2013). Recent studies show that the Xanthidae is polyphyletic and a major revision is required (Lai *et al.*, 2011; Thoma *et al.*, 2013).

Recently, the Australian government established a system of offshore marine reserves. These reserves consist of protected areas of the ocean that are managed for the conservation of their marine life, and include examples of different marine ecosystems and habitats (Department of Environment, 2013). It is difficult to describe the biodiversity within many of these reserves because there has been little biological sampling.

Thus, in late 2012 two surveys were undertaken in the Timor Sea by the RV *Solander* (SOL5650) and RV *Southern Surveyor* (SS2012T07). The RV *Solander* surveyed the proposed Oceanic Shoals Commonwealth Marine Reserve,

describing the fauna to increase the understanding of species within the reserve and contributing to the knowledge base of Australian tropical shelf habitats. This area includes a variety of seabed geomorphic features from depths of 30 to 180 m, including carbonate banks, terraces and pinnacles, recognised in the North and North-West Marine Region Plans as a Key Ecological Feature with potential biodiversity hotspot (Nichol *et al.*, 2013).

The second survey was undertaken as part of the transit of the RV *Southern Surveyor* between Darwin and Cairns in October 2012 (Przeslawski *et al.*, 2013). Brachyuran crabs were not the primary taxa of interest during these surveys but some species were encountered. Here we report on these collections of xanthid crabs in Australian waters of the Timor Sea.

Material and methods

Specimens were collected by staff from the Australian Institute of Marine Science (AIMS), Geoscience Australia (GA), University of Western Australia (UWA) and the Museum & Art Gallery of the Northern Territory (MGNT), aboard the RV *Solander* and during a transit leg aboard the RV *Southern Surveyor* and immediately fixed and preserved in 95% ethanol.

Morphological terminology generally follows Serène (1984) and Ng *et al.* (2008). Carapace length (Cl) is measured along the dorsal midline from the rostral apex to the posterior margin of the carapace, and carapace breadth (Cb) is the largest measurement between anterolateral teeth along the dorsal line. Specimens are deposited in Museum Victoria (NMV) and comparative material was examined from the Queensland Museum (QM). Other abbreviations: G1 is the first male gonopod; G2 is the second male gonopod; acq. refers to the sample number allocated to the specimen on board the vessel at the time of collection. Photos of specimens were taken at Museum Victoria using an SLR Nikon D300S digital camera with 60 mm Nikkon lens for large specimens, and a Leica DFC500 camera and microscope M205 high resolution digital camera system with Auto Montage software for small specimens. Some photographs of live specimens were taken during the survey.

Systematics

Family **Xanthidae** MacLeay, 1838

Subfamily **Actaeinae** Alcock, 1898

Actaeodes mutatus Guinot 1976

(Figure 1A)

Actaea areolata Dana, 1852b: 162.—Dana, 1855: pl. 8 fig. 1.—A. Milne Edwards, 1865: 264 (not *Actaeodes areolatus* Dana, 1852a: 77). *Actaea areolata*? Miers, 1884: 209.—Rathbun, 1924: 16. *Actaeodes areolatus*; Guinot, 1967: 561.—Sakai, 1976: 449. *Actaeodes mutatus* Guinot, 1976: 247.—Serène, 1984: 133 (key) 134 (key).—Morgan, 1990: 41.—Davie, 2002: 513.

Material examined. NMV J46921, 1 female (Cb = 18.1 mm, Cl = 11.5 mm), northern Australia, Arafura Sea, Survey SS2012t07 Stn 12 (acq. 272), 10°57.76'–57.79'S, 136°48.03'–48.03'E, 60.6–62.8 m, benthic sled, 18 Oct 2012.

Colour in preservative. Carapace reddish brown with orange granules on the lobes. Ambulatory legs brown with beige setae. Chelipeds reddish brown with orange granules on the lobes dorsally, and beige ventrally, fingers black. Abdomen brown with beige setae.

Remarks. *Acteodes mutatus* occurs across tropical Australia and the Indo-West Pacific. It is similar to *Acteodes semoni* (Ortmann, 1894) but can be distinguished by the basal antennal segment which fills the orbital hiatus that is normally open, whereas in *A. semoni* the basal antennal segment is excluded from the orbit. Another character used to define *A. mutatus* is the subdivision of 3M into three parts. In our specimen this subdivision is not well defined. However, it is likely this character is variable within the species.

Distribution. Indo-west Pacific (Mergui Archipelago, to southern Japan, and east to French Polynesia) (Davie, 2002).

Paractaea rufopunctata plumosa Guinot, in Sakai, 1976

(Figure 1B)

Paractaea rufopunctata forma *plumosa* Guinot, 1969: 248, fig. 21.

Paractaea rufopunctata plumosa Sakai, 1976a: 450, fig. 240b, pl. 159, fig. 1. —Muraoka, 1998: 42.

Paractaea rufopunctata f. *plumosa* Serène, 1984: 121(key), 122(key), pl. 16C.

Material examined. NMV J46922, 1 male (Cb=29.1 mm, Cl=19.7 mm), northern Australia, Arafura Sea, Survey SS2012t07 Stn 08 (acq. 204), 11°13.32'–13.38'S, 134°45.12'–45.12'E, 27.7–27.9 m, benthic sled, 17 Oct 2012; NMV J54546, 1 female (Cb=27.2 mm, Cl=18.1 mm), off Ningaloo North, SS10/2005 153, 21°59.17'–59.79'S, 113°49.2'–49.14'E, 165–166 m, beam trawl, 11 Dec 2005; NMV J61124, 1 ovigerous female (Cb=11.9 mm, Cl=8.5 mm), 1 female (Cb=13.1 mm, Cl=9.1 mm) north-western Australia, SS05/2007 188, 12°26.7'–26.96'S, 123°36.05'–36.59'E, 95–95 m, beam trawl, 6 July 2007; NMV J17772, 2 females (Cb=15.3–15.5 mm, Cl=10.2–10.4 mm), Australia, Queensland, Tryon island (Capricorn Group) 23°14'S, 151°46'E, 1 m, Sep 1970.

Colour in preservative. Carapace dark brown with orange lobes; medial lobe of subdivided 2M, top of 3M, 1P, and inside parts of 5L highlighted with dark orange granules. Ambulatory legs pale brown with patch of orange granules on the dorso-medial region of merus and propodus, beige ventrally. Chelipeds dark brown with orange and dark orange patches; fingers black. Abdomen beige with orange patches between segments.

Remarks. Guinot (1969) described a number of “formes” of this species but only a few are currently considered valid subspecies. The Arafura sea specimen most closely resembles the subspecies *P. rufopunctata plumosa* as the cardiac region is not subdivided into 2 parts, and the black colouration of the fixed finger of the male chelipeds extends onto the palm (Guinot, 1976; Serene 1984). Specimens from Western Australia reported as *Paractaea rufopunctata* (see Poore *et al.* 2008) also fit the description of *P. rufopunctata plumosa*.

Distribution. Indo-Pacific Oceans including northern Australia (Guinot, 1976; Sakai, 1976; Serène, 1984). Depth range: shallow waters–130 m.

Subfamily **Euxanthinae** Alcock, 1898

Euxanthus sp.

(Figures 1C, 2A–F)

Material examined. NMV J46923, 1 juvenile male (Cb=7.9 mm, Cl=5.6 mm), northern Australia, Timor Sea, Oceanic Shoals Commonwealth Marine Reserve, Survey SOL5650 station unknown (acq. 20052), 12 Sep–6 Oct 2012.

Description. Carapace (Figs. 2A; 2B) about 1.4 times as broad as long, regions well defined, convex, strongly areolated, smooth; 2M entirely divided longitudinally; 3M and 3L distinct, entire; 1L indistinct; 4M fused with 3M; 4L merging with third anterolateral tooth; 2L partially divided transversely with shallow groove on medial margin; 2P distinct; 1R

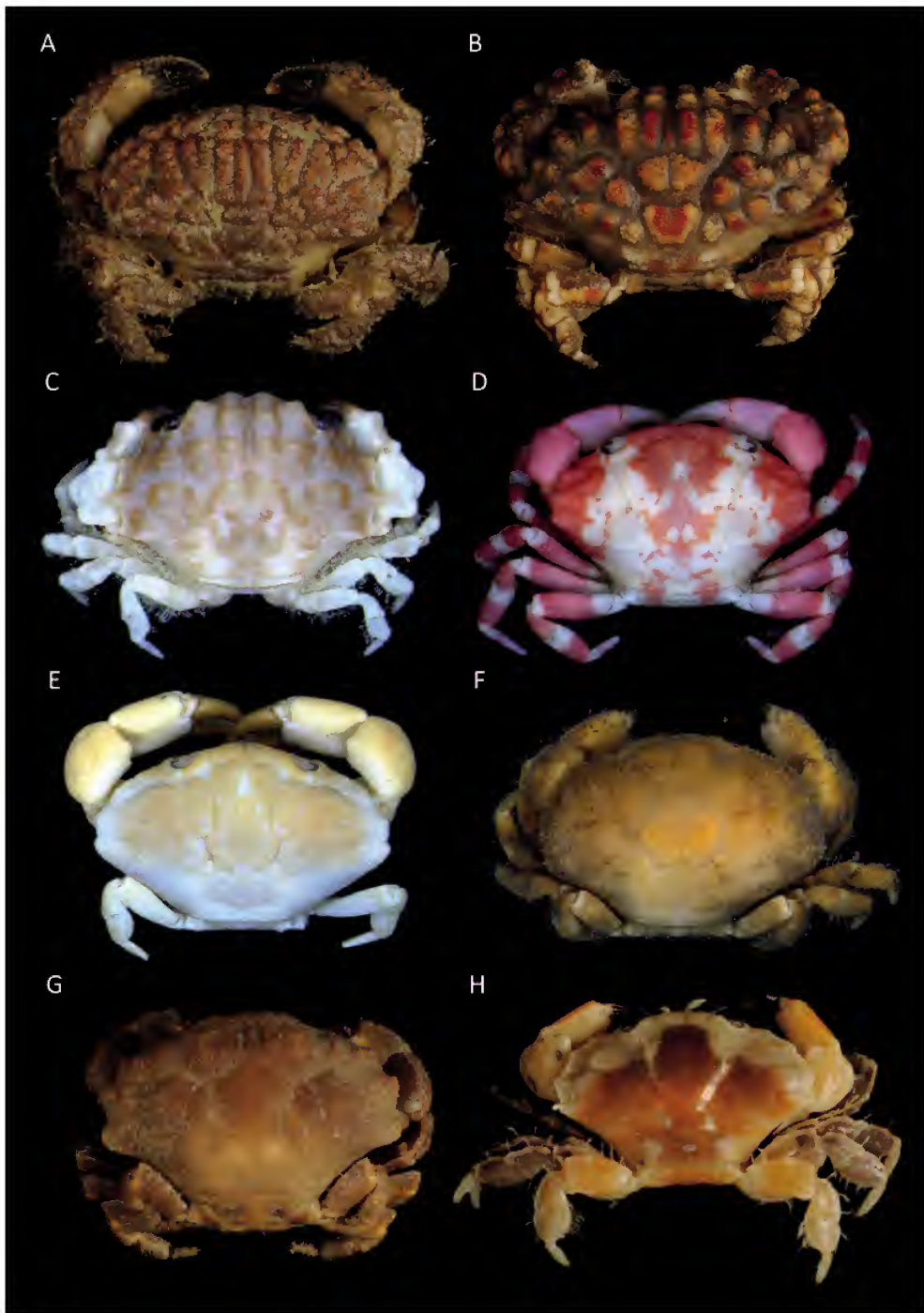


Figure 1. A, *Actaeodes mutatus* Guinot 1976, female, 18.1 X 11.5 mm (NMV J46921); B, *Paractaea rufopunctata plumosa* Guinot, in Sakai, 1976, male, 29.1 X 19.7 mm (NMV J46922); C, *Euxanthus* sp., male, 8.12 X 5.83 mm (NMV J46923); D, *Liomera edwardsi* Kossmann, 1877, male, 9.37 X 5.83 mm (NMV J46927); E, *Liomera margaritata*, male, 16.3 X 9.8 mm (NMV J46928); F, *Atergatopsis granulata* A. Milne Edwards, 1865, female, 19.6 X 12.9 mm (NMV J46929); G, *Atergatopsis alcocki*, male, 32.4 X 22.4 mm (NMV J46930); H, *Lophozozymus dodone* (Herbst, 1801), male, 16.7 X 10.4 mm (NMV J46931). Photos: T. Iwasa-Arai.

separated from 2R by indistinct transverse granular ridge, 2R, 3R indistinct. Pterygostomial region setose, tuberculate. Front (Fig. 2C) about 0.3 times carapace width, bilobed, distinctly produced beyond internal orbital angle; lobes separated by V-shaped cleft, which continues on frontal region as shallow groove. Supraorbital margin indistinctly granular, with no clear external orbital tooth. Orbits relatively small, width about 0.2 times carapace width. Eyes with short stalks, smooth; corneas well developed. Anterolateral margin with 4 broadly triangular teeth: first rounded, apices of third tooth at the point of maximum carapace width. Posterolateral margin concave, convergent posteriorly. Median part of posterior carapace margin almost straight.

Antennules folding transversely. Basal antennal segment large, smooth, subrectangular, occupying entire space between antennular fossa, internal orbital angle, filling orbital hiatus; flagellum arising from distal margin, not reaching outer edge of orbit. Posterior margin of epistome with median projection.

Outer surface of third maxillipeds smooth (Fig. 2D). Merus subquadrate, median length about half that of ischium, with 2 shallow depressions on either side of low, submedian, smooth ridge. Margins smooth, anterior, internal and external margins slightly concave. Ischium subrectangular, inner margin with short, stiff setae; with shallow, longitudinal submedian groove. Exopod smooth, tapering toward distal end, falling short of anterior edge of merus; flagellum long.

Surface of thoracic sternum smooth, anterior region elongate. Sternites 1–2 completely fused to form triangular plate. Sternites 3–4 completely fused, with suture visible at sternite edges and represented by a transverse furrow; sternite 4 with oblique depression on either side of median. Intersternal sutures depressed, giving sternites 5–7 a raised appearance. Sterno-abdominal cavity deep; anterior limit reaching to imaginary line joining posterior edges of cheliped coxae; tubercle for abdominal locking mechanism on sternite 5 slightly nearer to suture with sternite 4.

Chelipeds similar, subequal. Fingers (Fig. 2F) shorter than palm, cutting edges with 4 teeth, brown, tips pointed. Dactylus slightly curved, with 3 granulate ridges and deep submarginal groove along length, stiff short setae on upper margin. Fixed finger slightly flexed with 3 smooth ridges and broad submarginal groove continuing from palm. Palm outer surface with 4 large nodules, with 2 irregular rows of granules near convex proximal-lower margin; inner surface relatively smooth. Carpus short, dorsal and ventral surface smooth, outer surface with 2 prominent round expansions, upper margin with 2 small nodules. Inner surface of fingers, palm and carpus coapted against pterygostomial/hepatic region of carapace. Merus rugose, ventral surface tuberculate, slightly longer than carpus, with rectangular, ventro-distal tooth apposed against carpus.

Ambulatory legs (Fig. 2E) smooth, edges with setae; second leg longest, coxa-to-dactylus length about 0.8 times carapace width. Merus subrectangular and flattened in cross-section. Dorsal surface of carpus with one large nodule and serrated anterior edge. Propodus subquadrate, with two smaller nodules on the dorsal surface, short setae; terminates distally in curved chitinous claw.

External surface of male abdomen, telson smooth.

Abdominal somites 1–2 subtrapezoidal, with two shallow longitudinal grooves on either side of central raised region. Somites 3–5 immovably fused, with a transverse depression between somites 3 and 4; lateral margins slightly concave. Somite 6 quadrangular, central region slightly raised, lateral margins slightly concave. Telson subtriangular with rounded tip, lateral margins relatively straight, median length about 0.7 times basal width, about 0.7 times shorter than penultimate somite.

G1 not observable, G2 very reduced in size, without setae or spines.

Colour in preservative. Carapace pale rose with pale orange patches in lateral part of 5L, 1R, bottom of 4M, medial part of 2M and 2L, and the anterolateral edges of anterolateral teeth; ambulatory legs, chelipeds and abdomen pale rose.

Remarks. As the material described herein is limited to a single small juvenile male, we hesitate to describe it as a new species at this stage. *Euxanthus* sp. is similar to *Euxanthus ruali* Guinot, 1971 and *Euxanthus herdmanni* Laurie, 1906 which both have four teeth on the anterolateral margin of the carapace and a smooth dorsal surface. The material is most similar to *E. herdmanni* described from the Philippines (see figure 1D, Mendoza and Ng, 2010), but can be distinguished by: the carapace shape which is narrower in *E. herdmanni* (Cb/Cl holotype= 1.33) than *Euxanthus* sp. (Cb/Cl= 1.41); anterolateral teeth that are acute and noticeably larger in *Euxanthus* sp. than *E. herdmanni*; the frontal part of the carapace, in which the frontal and orbital lobes are of similar size in *E. herdmanni*, while in *Euxanthus* sp. the frontal lobes are distinctly larger than the orbital lobes. *Euxanthus* sp. can be distinguished from *E. ruali* from New Caledonia and Japan, by the anterolateral teeth which are unequal in size (last two larger) in *E. ruali*, and subequal in *Euxanthus* sp.

Subfamily **Liomerinae** Sakai, 1976

Liomera edwardsi Kossmann, 1877

(Figure 1D)

Liomera edwardsi Kossmann, 1877: 28.

Carpilodes edwardsi.—Miers, 1886: 133(part).—Odhner, 1925: 13, pl. 1, fig. 5.—Holthuis, 1953: 13.—Serène & Luom, 1960: 176 (key).

Carpilodes laevis.—Milne-Edwards, Nobili, 1906b: 215 (part).—Michel, 1964: 23 (not A. Milne-Edwards, 1873).

Carpilodes sayademathensis Rathbun, 1911: 211, pl. 17, fig. 5.—Ward, 1942: 83.

Liomera edwardsi.—Guinot, 1967: 266.—Serène, 1968: 72.—Sakai, 1976: 393, fig. 209a, pl. 139, fig. 5.—Muraoka, 1998: 38.—Davie, 2002: 543.

Liomera (Liomera) edwardsi.—Serène, 1984: 49 (key), 54 (key), 58, pl. 5C.

Material examined. NMV J46927, 1 male, Cb=9.4 mm, Cl=5.8 mm (acq. 10282) Survey SOL5650, Stn 014 BS002, 12°4.133'–4.133'S, 127°26.164'–26.164'E, 36–34 m, Benthic sled, 17/09/2012; NMV J46926, 1 female Cb=14.2 mm, Cl=9.2 mm (acq. 10100) Survey SOL5650, Stn 019 GR026, 12°4.842, 127°25.815'E, 49 m, Smith Mac, 18/09/2012; NMV J46924, 1 female, Cb=10.8 mm, Cl=7.1 mm (acq. 10327) Survey SOL5650, Stn 016 BS004, 12°4.491'S, 127°25.742'E,

45 m, Benthic sled, 17/09/2012; NMV J46925, 1 male, Cb=15.6 mm, Cl=9.8 mm (acq. 20251) Survey SOL5650, Stn 074 BS022, 12°4.49'–4.52'S, 127°26.62'–26.62'E, 59–66 m, Benthic sled, 03/10/2012.

Colour in preservative. Carapace crimson with white patches mostly on 3R, sometimes extending to 5L and 2L. Ambulatory legs crimson with bands of white at the distal and proximal ends; chelipeds crimson with black fingers. Abdomen mostly white with crimson patches. All specimens presented crimson and white colouration, but differ in proportion of white.

Remarks. *Liomera edwardsi* was the only species with more than one specimen collected during the Timor Sea Oceanic Shoals survey. *Liomera edwardsi* is very similar to *L. tristis* (Dana, 1852), *L. laevis* (A. Milne-Edwards, 1873), *L. sagamiensis* (Sakai, 1939) and *L. nigropunctata* (Serène & Van Luom, 1960), but can be distinguished by a projecting areole well separated from 2M and 1F (Serène, 1984) on the dorsal surface. This species was previously recorded in Australia by Odhner (1925) from one specimen collected from Holothuria Bank, Northwest Australia.

Distribution. Comoro Islands (Mayotte), Madagascar (Tulear), Djibouti and Red Sea, South China Sea, Japan (Kii Peninsula), Solomon Islands (Peros Bankos), Northwest Australia, Australia (Holothuria Bank) (Odhner, 1925; Sakai, 1976; Serène, 1984). Depth range 15–59 m.

***Liomera margaritata* (A. Milne-Edwards, 1873)**

(Figure 1E)

Carpilodes margaritatus Milne-Edwards A., 1873: 182, pl. 5, fig. 2.—Henderson, 1893: 353. —Whitelegge, 1897: 131.—Alcock, 1898: 85.—Odhner, 1925: 24, pl. 2, fig. 4.—Gravely, 1927: 146, pl. 21, fig. 26. —de Man, 1929a: 1. —de Man, 1929b: 2.—Chopra & Das, 1937: 395, fig. 5.—Sakai, 1939: 476, fig. 36.—Lin, 1949: 22.—Serène & Luom, 1960: 174, 178(key), 185, fig. 2F, pl. 2D.—Buitendijk, 1960: 261, fig. 3b.—McNeill, 1968: 74.

Liomera margaritata.—Sakai, 1965b: 144, pl. 72, fig. 3.—Guinot, 1967: 266. —Serène, 1968: 72. —Sakai, 1976: 396, fig. 211. —Dai & Yang, 1991: 271, fig. 145 (2), pl. 34 (2).—Yu et al., 1996. —Jeng, 1997.—Davie, 2002: 543.

Liomera (Liomera) margaritata.—Serène, 1984: 63, fig. 23, pl. 7A. *Chlorodius exiguus* Targioni Tozzetti, 1877: 48, pl. 4, figs 1–5, 9.—Odhner, 1925: pl. 5, figs 8, 8a.

Carpilodes striatus de Man, 1887: 232, pl. 8, fig. 1.

Carpilodes ruber.—Ortmann, 1893: 468. (not A. Milne Edwards, 1865)

Carpilodes diodoreus Nobili, 1906a: 403.—Nobili, 1906b: 216, pl. 10, fig. 9.—Klunzinger, 1913: 138.

Not *Carpilodes rugipes* (Heller, 1861).—Rathbun, 1910: 351.

Not *Carpilodes margaritatus*.—Lanchester, 1900b: 731.= aff. *Atergatopsis amoyensis* de Man, 1879.

Material examined. NMV J46928, 1 male, Cb=16.3 mm, Cl=9.8 mm (acq. 292) Survey SS2012t07, Stn 11, 10°57.66'–57.73'S, 136°47.68'–47.94'E, 108.8–92.8 m, Benthic sled, 18/10/2012. NMV J10923, 1 female, Cb=9.1 mm, Cl=5.7 mm, Australia, Queensland, Dingo Beach. Coll. 08/08/1971.

Comparative material examined. QM W36046, 1 male, Cb=14.6 mm, Cl=9.4 mm, Great Barrier Reef Seabed Diversity Survey. Site id: 2731: 22°2.7'S, 150°36.3'N, 53.4 m, RV *Lady Basten*,

23/09/2004; QM W37911, 1 male, Cb=21.6 mm, Cl=13.4 mm, Site id: 2126: 22°59.7'S, 149°58.5'N, 52.9 m, RV *Lady Basten*, 29/09/2004.

Colour in life. Carapace orange with white anterolateral margins, 1P, 2P and 3R white. Ambulatory legs orange. Chelipeds orange dorsally and white ventrally with dark brown fingers. Abdomen white (Fig. 5).

Colour in preservative. Carapace pale orange with white anterolateral margins, 1P, 2P and 3R white. Ambulatory legs light orange. Chelipeds orange dorsally and white ventrally with dark brown fingers. Abdomen white.

Remarks. Within the genus *Liomera*, this species is characterised by a completely divided 2M region, which makes it similar to, *Liomera monticulosa* (A. Milne-Edwards, 1873), *Liomera rugipes* (Heller, 1861), and *Liomera rubra* (A. Milne-Edwards, 1865). It differs from the latter three species, which have 1M separated from the interior part of 2M. Serene (1984) describes *L. margaritata* with well-defined regions 4L, 5L, and 6L, but in our specimens these regions are fused and not well defined. Also, colour in live specimens are different, described as uniformly pale violet by Serene (1984), while our specimens are orange colour with white anterolateral margins. As the G1 morphology agrees well with illustrations of *L. margaritata* provided by Serene (1984), we conclude that the variation described above is likely to be intra-specific.

Distribution. Queensland (Great Barrier Reef, NE coast); Indo-west central Pacific Oceans (Madagascar and Red Sea to Japan, New Guinea, Samoa, New Caledonia). Depth range subtidal–107 m.

Subfamily **Zosiminae** Alcock, 1898

***Atergatopsis alcocki* (Laurie, 1906)**

(Figure 1G)

Actaea alcocki Laurie, 1906: 403.—Odhner, 1925: 43, pl. 3, fig. 4.—Balss, 1938b: 54, pl. 2, figs 3–4.

Xantho bowensis.—Rathbun, 1923: 103, pl. 20, figs 1–3.

Atergatopsis alcocki.—Guinot, 1969: 232, fig. 15a–c.—Sakai, 1976: 413, fig. 218.—Serène, 1984: 141 (key), 142 (key).

Aff. *Atergatopsis alcocki*.—Serène, 1984: 143 (list), pl. 20 E.

Material examined. NMV J46930, 1 male, Cb=32.4 mm, Cl=22.4 mm (acq. 118) Survey SS2012t07, Stn 02, 11°13.78'–13.78'S, 134°44.47'–44.44'E, 23.3 m, Benthic sled, 17/10/2012.

Colour in preservative. Carapace brown, darker in the first half, until last anterolateral tooth; ambulatory legs brown/orange; chelipeds brown with black chelae; abdomen beige.

Remarks. The specimen from the Timor Sea agrees well with the description in Laurie (1906). The holotype is described by Laurie as yellowish with a circular brown patch in the gastric region in live specimens. The single male specimen from the Timor Sea lacked the brown patch as does the specimen described by Rathbun (1923, plate 20) collected in Queensland, Australia.

Distribution. Sri Lanka, Singapore, Japan (Kii Peninsula), Australia (Queensland and Northern Australia) (Laurie, 1906; Rathbun, 1923; Sakai, 1976). Depth range 15–35 m.

***Atergatopsis granulata* A. Milne-Edwards, 1865**

(Figure 1F)

Atergatopsis granulatus A. Milne-Edwards, 1865: 255, pl 13, figs 2, 2b.—Kossmann, 1877: 22.—Cano, 1889b: 190.—Nobili, 1906b: 235.—Klunzinger, 1913: 156(60).—Balss, 1935: 137; 1938: 55, pl. 3, fig. 3.—Monod, 1938: 122, fig. 14.—Buitendijk, 1960: 283.—Guinot, 1964: 14, fig. 2a, b; 1967c: 262; 1971: 1074.—Serène, 1968: 74.—Ribes, 1978: 126.—Serène, 1984: 143, fig 83, pl. 20b.

Not *Atergatopsis granulatus*.—Miers 1884b: 529 = not *Atergatopsis*, according to Buitendijk (1960).

Not *Atergatopsis granulatus*.—Miers 1886: 123 = *Atergatopsis tweediei* Balss, 1938b, according to Buitendijk (1960).

Not *Atergatopsis granulatus*.—Balss, 1924 a: 6, fig. 1 = *Banareia parvula* (Krauss, 1843).

Material examined. NMV J46929, 1 female, Cb=19.6 mm, Cl=12.9 mm (acq. 10327) Survey SOL5650, Stn 016 BS004, 12°4.8'–12°4.8'S, 127°25.74'–127°25.77', 45–46 m, Benthic sled, 17/09/2012.

Colour in preservative. Carapace pale orange with a pair of dark orange spots anterior to 5L. Ambulatory legs same colour as carapace. Chelipeds pale orange with black fingers. Abdomen beige.

Remarks. While this is the first record of this species in Australian waters, the species has previously been recorded from across the Indian Ocean and as far as the South China Sea. It is very similar to *Atergatopsis tweediei* Balss, 1938 described from the Seychelles, South-East Asia, and Papua New Guinea. Both species have chelipeds with chisel-shaped fingers, and a single large subproximal tooth on the pollex. According to Serène (1984) the two species can be distinguished by the amount of granulation on the carapace. *Atergatopsis tweediei* is entirely smooth on most of its median carapace, with granules only on the anterolateral margins. While the carapace of *A. granulata* is entirely covered in granules, they are smaller and less numerous in the median and posterior parts. In our specimen, region 3M of the carapace is almost smooth but all other regions are granular.

Distribution. Madagascar, Zanzibar, Pakistan (Karachi), Aldabra, South China Sea and New Guinea (Serène, 1984). Depth range: 26–46 m.

***Lophozozymus dodone* (Herbst, 1801)**

(Figure 1H)

Cancer dodone Herbst, 1801: 37, pl. 52, fig. 5.

Xantho radiatus Milne-Edwards H., 1834: 398.

Xantho lamelligera White, 1848: 225.

Atergatis lateralis White, 1848: 225.—Adams & White, 1848: 39, pl. 8, fig. 1.

Xantho nitidus Dana, 1852a: 74.—Dana, 1852b: 166.—Dana, 1855: pl. 8, fig. 4a-b.

Atergatis elegans Heller, 1862: 519.—Heller, 1865: 7, pl. 1, fig. 3.

Lophozozymus radiatus Milne-Edwards A., 1873: 206 (part).

Lophozozymus dodone Hilgendorf, 1879: 789 (nomen nudum).—

Miers, 1884: 517, 527.—Henderson, 1893: 361.—Ortmann, 1893: 457.—Ortmann, 1894b: 50.—Alcock, 1898: 108.—Calman, 1900: 6.—Borradaile, 1902: 361.—Laurie, 1906: 399.—Rathbun, 1907: 39.—Rathbun, 1911: 214.—Bouvier, 1915: 289.—Odner, 1925: 82.—Balss, 1938a: 39.—Ward, 1942: 85.—Tweedie, 1950: 115.—Barnard, 1950: 218, fig. 39f, g.—Buitendijk, 1960: 294, fig. 7b.—Edmondson, 1962: 230, fig. 3f.—Michel, 1964: 27.—Sakai, 1965a: 45, pl. 6, fig. 6.—Sankarankutty, 1966: 50.—Guinot, 1967: 266.—Garth, 1973: 319.—Sakai, 1976: 407, pl. 146, fig. 2.—Serène, 1977: 50.—Guinot, 1979: 64, pl. 8, fig. 1-1a.—Kensley, 1981: 44.—Serène, 1984: 168 (key), 169 (key), 170, pl. 24E.—Sakai K., 1999: 34, pl. 18B.—Davie, 2002: 543.

Lophozozymus dodone.—de Man, 1887: 270, pl. 10, fig. 2.

Not *Lophozozymus dodone*.—Rathbun, 1906: 846, pl. 8, figs 2, 2a. = *Lophozozymus rathbunae* Ward, 1942.

Not *Lophozozymus dodone*.—Forest & Guinot, 1961: 54, fig. 39. = *Lophozozymus glaber* Ortmann, 1893.

Material examined. NMV J46931, 1 male, Cb=16.7 mm, Cl=10.4 mm (acq. 20921) Survey SOL5650, Stn 063 BS020, 11°23.83'–23.81'S, 126°54.49'–54.46'E, 88–85 m, Benthic sled, 01/10/2012.

Colour in preservative. Front and anterolateral margins of carapace beige, with remnants brownish orange. Ambulatory legs pale orange, patches of 3R and 1P and 6L beige. Chelipeds pale orange in dorsal view and beige in ventral view with black fingers. Abdomen beige with segments 1 and 2 brownish orange.

Remarks: Widely distributed in tropical Australia, *L. dodone* is distinctive in the genus by its rugosities and punctuations on the carpus and external face of the cheliped palm of the male (Serène, 1984). *Lophozozymus dodone* was compared with images available of specimens collected from the central Pacific (Legall and Poupin, accessed 2013) and it seems that *L. dodone* can have different colour patterns also in life, varying from the carapace being dark brown with the front and anterolateral margins beige to the carapace being vivid red with anterolateral margins white, differing also in the amount of white/beige on the front and anterolateral margins, sometimes with white patches that can extend until the second half of the carapace.

Lophozozymus dodone was previously only known from shallow waters (7–8 m) but is recorded here from a depth of 88 m.

Distribution. Hawaii, Tahiti, Fiji, Cocos-Keeling, South Africa, Japan (Amami Group and Ishigaki Island), Andaman Sea, and Australia (Northern Australia) (Sakai, 1976) Depth range 7–88 m.

Acknowledgments

We are grateful to Chris Rowley and Melanie Mackenzie (Museum Victoria) for collection management support, the staff from the Australian Institute of Marine Science (AIMS), Geoscience Australia (GA), University of Western Australia (UWA) and the Museum and Art Gallery of the Northern Territory (MGNT), who collected specimens during the surveys.

Surveys were undertaken by the National Environmental Research Program (NERP) program, an Australian Government initiative. The NERP Marine Biodiversity Hub is a collaborative partnership between the Charles Darwin University, University of Tasmania, University of Western Australia, CSIRO, Geoscience Australia, Australian Institute of Marine Science and Museum Victoria.

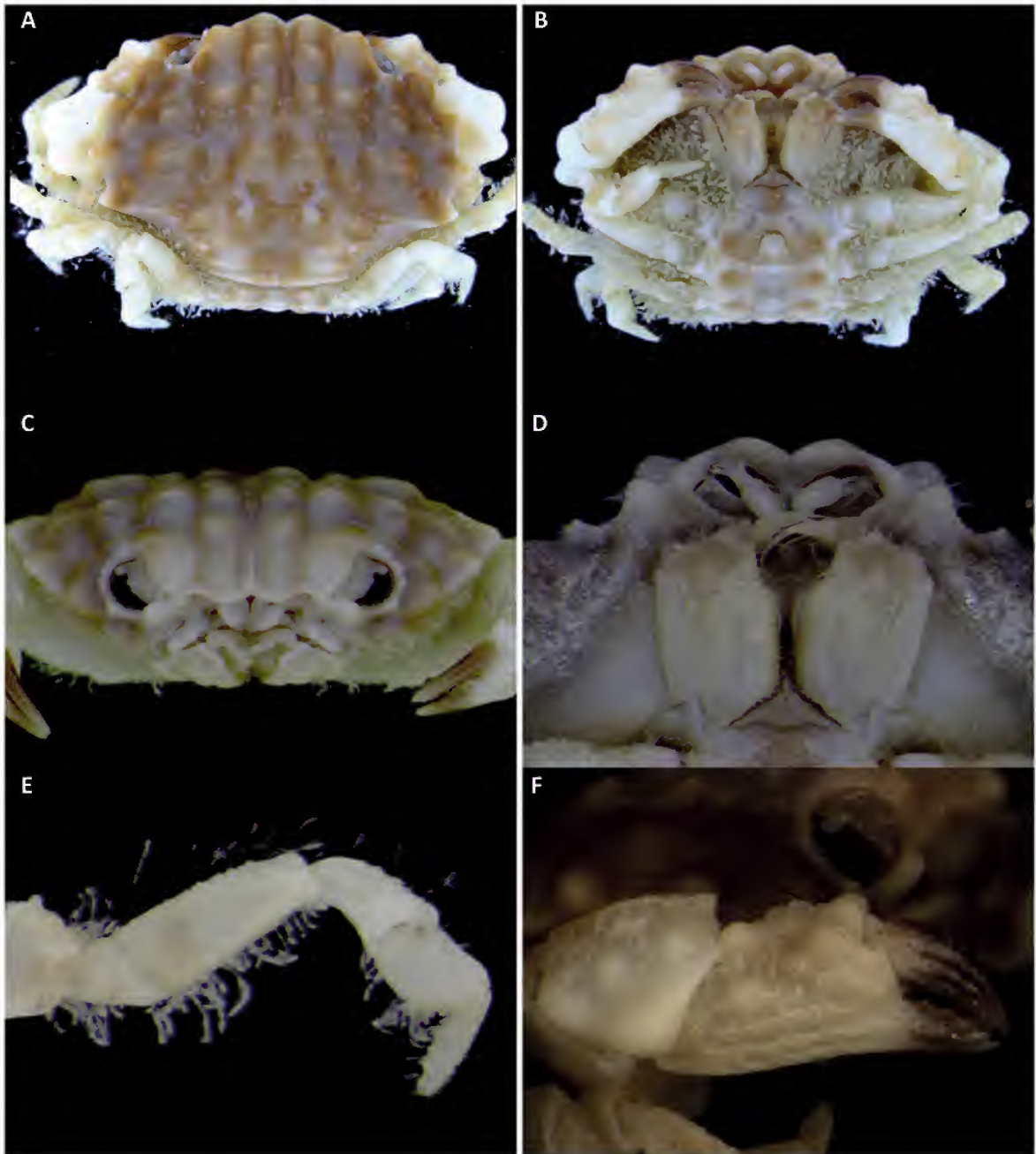


Figure 2. *Euxanthus* sp., male (NMV J46923) (7.9 X 5.6mm): A, carapace, dorsal view; B, carapace, ventral view; C, frontal view; D, third maxilliped; E, fourth right leg; F, right cheliped.

We also thank Mark Elgar (University of Melbourne) for his support, and Peter Davie (Queensland Museum) for taxonomic advice and the loan of comparative material.

Finally, we thank the Program *Science Without Borders*, Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq), Brazil.

References

- Adams, A. and A. White, 1848. Crustacea. Part 1. In: A. Adams (ed.), The zoology of the voyage of H.M.S. *Samarang*, under the command of Captain Sir Edward Belcher, during the years 1843-1846, 1-32, pls 1-6. Benham & Reeve, London.
- Ahyong, S., Lowry, J.K., Alonso, M., Bamber, R.N., Boxshall, G.A., Castro, P., Gerken, S., Karaman, G.S., Goy, J.W., Jones, D.S., Meland, K., Rogers, D.C., and Svavarsson, J. 2011. Subphylum Crustacea. In: Zhang, Z.Q. (ed), Animal biodiversity: an outline of higher-level classification and survey of taxonomic richness. *Zootaxa*, 3148: 165-191.
- Alcock, A.W., 1898. Materials for a carcinological fauna of India. No. 3. The Brachyura Cyclometopa. Part 1. The Family Xanthidae. *Journal of the Asiatic Society of Bengal*, Calcutta, 67, part 2(1): 67-233.
- Balss, H., 1935. Brachyura of the Hamburg Museum expedition to south-western Australia, 1905. *Journal of the Royal Society of Western Australia* 21: 113-151, fig. 1-5, pl. 13.
- Balss, H., 1938a. Die Dekapoda Brachyura von Dr. Sixten Bock's Pazifik Expedition 1917-1918. *Göteborgs Kungliga Vetenskaps- och Vitterhets-Samhälles Handlingar*, Ser. B, 5(7): 1-85, figs 1-18, pls 1-2.
- Balss, H., 1938b. Über einige Xanthidae (Crustacea, Dekapoda) von Singapore und Umgebung. *Bulletin of the Raffles Museum*, 14: 48-63, figs 1-2, pls 2-3.
- Barnard, K.H., 1950. Descriptive catalogue of South African Decapod Crustacea (Crabs and Shrimps). *Annals of the South African Museum*, 38: 1-837, figs 1-154.
- Borradaile, L.A., 1902. Marine Crustaceans. III. The Xanthidae and some other crabs. In: J.S. Gardiner (ed.), The Fauna and Geography of the Maldives and Laccadive Archipelagoes, being the Account of the Work carried on and the Collections made by an Expedition during the years 1899-1900. *Transactions of the Linnean Society of London*, (Zoology), 1(3): 237-271, figs 41-60. Cambridge University Press.
- Bouvier, E.L., 1915. Décapodes marcheurs (Reptantia) et Stomatopodes recueillis à l'île Maurice par M. Paul Carié. *Bulletin scientifique de la France et de la Belgique*, sér. 7, 48(3): 178-318 (1-141), figs 1-42, pls 4-7. [1915/V]
- Buitendijk, A.M., 1960. Biological results of the Snellius Expedition XXI. Brachyura of the families Atelecyclidae and Xanthidae (Part I). *Temminckia* 5: 252-338.
- Calman, W.T., 1900. On a collection of Brachyura from Torres Straits. *Transactions of the Linnean Society of London*, (Zool.), (2) 8(1): 1-50, pls 1-3. [1900/IX]
- Cano, G., 1889. Viaggio della R. Corvetta Vettor Pisiano attorno al globo. Crostacei Brachiuri ed Anomuri. *Boll. Soc. Nat. Napoli*, ser. 1, 3: 169-268, pl. 7.
- Chopra, B.N. & K.N. Das, 1937. Further notes on Crustacea Decapoda in the Indian Museum. IX. On three collections of crabs from Tavoy and Mergui Archipelago. *Record of the Indian Museum*, Calcutta, 39(4): 377-434, figs 1-21, pl. 6.
- Dai, A. & S. Yang, 1991. Crabs of the China Seas, i-iv, 1-608, figs 1-295, pls 1-74. China Ocean Press, Beijing and Springer-Verlag, Berlin Heidelberg New York Tokyo, English edition. (Translation from Chinese original 1986.)
- Dana, J.D., 1852a. Conspectus Crustaceorum, etc., Conspectus of the Crustacea of the Exploring Expedition under Capt. C. Wilkes, U.S.N., including the Paguridea, continued, the Megalopidea, and the Macroura. Paguridea, continued, and subtribe Megalopidea. *Proceedings of the Academy of Natural Sciences Philadelphia*, 6: 73-86 (or 6-28).
- Dana, J.D., 1852b. Crustacea. United States Exploring Expedition during the years 1838, 1839, 1840, 1841, 1842, under the command of Charles Wilkes, U.S.N., 13(pt. 1): i-viii, 1-685, pl. 8.
- Dana, J.D., 1855. Crustacea. United States Exploring Expedition during the years 1838, 1839, 1840, 1841, 1842 under the command of Charles Wilkes, U.S.N., 14(Atlas): 1-27, pls 1-96.
- Davie, P.J.F., 1989. New records of *Demania* (Crustacea: Decapoda: Xanthidae) from Australia. *Memoirs of the Queensland Museum* 27: 123-128.
- Davie, P.J.F., 2002. *Crustacea: Malacostraca: Eucarida (Part 2): Decapoda - Anomura, Brachyura*. Vol. 19.3B. CSIRO Publishing: Melbourne. xiv, 641 pp.
- Davie, P. 2013., Xanthidae MacLeay, 1838. World Register of Marine Species. <http://www.marinespecies.org/aphia.php?p=taxdetails&id=106769> on 2013-11-15.
- Davie, P.J.F., and Turner, P.A. 1995. A new species and a new record of *Hepatoporus* from north-western Australia (Crustacea: Decapoda: Xanthidae). *Memoirs of the Queensland Museum* 37: 83-86.
- De Grave, S., Pentcheff, N.D., Ahyong, S.T., Chan, T.-Y., Crandall, K.A., Dworschak, P.C., Felder, D.L., Feldmann, R.M., Fransen, C.H.J.M., Goulding, L.Y.D., Lemaitre, r., Low, M.E.Y., Martin, J.W., Ng, P.K.L., Schweitzer, C.E., Tan, C.G.S., Tshudy, S.H.D., and Wetzer, R. 2009. A classification of living and fossil genera of decapod crustaceans. *Raffles Bulletin of Zoology, Supplement* 21: 1-109.
- Department of Environment. 2013. Commonwealth marine reserves. <http://www.environment.gov.au/topics/marine/marine-reserves/overview>
- Edmondson, C.H., 1923. Crustacea from Palmyra and Fanning Islands. *Bulletin of the Bernice P. Bishop Museum*, Honolulu, 5: 1-43, figs 1-3, pls 1-2.
- Edmondson, C.H., 1962. Xanthidae of Hawaii. *Occasional Papers of the Bernice P. Bishop Museum*, Honolulu, 22(13): 215-309, figs 1-34.
- Forest, J., and D. Guinot, 1961. Crustacés Décapodes Brachyours de Tahiti et des Tuamotu. In: Expédition française sur les récifs coralliens de la Nouvelle Calédonie. Vol. Préliminaire: i-xi, 1-195, figs 1-178, pls 1-18, 7 maps, tables 1-3. Éditions de la Fondation Singer-Polignac.
- Garth, J.S., 1973. The brachyuran crabs of Easter Island. *Proceedings of the California Academy of Sciences*, 39(17): 311-336, figs 1-6.
- Garth, J.S., and H.S. Kim, 1983. Crabs of the family Xanthidae (Crustacea: Brachyura) from the Philippine Islands and adjacent waters based largely on collections of the U.S. Fish Commission Steamer *Albatross* in 1908-1909. *Journal of Natural History*, London, 17: 663-729.
- Grant, F.E., and McCulloch, A.R. 1906. On a collection of Crustacea from the Port Curtis district, Queensland. *Proceedings of the Linnean Society of New South Wales* 1906: 2-53, pls 51-54.
- Gravely, F.J., 1927. Decapoda (excl. Paguridea) and Stomatopoda. In: The littoral fauna of the Krusadai Island in the Gulf of Manaia with Appendices on the Vertebrates and Plants. *Bulletin of the Madras Government Museum*, 1(1): 135-155, figs 1-2, pls 19-26.
- Guinot, D., 1964. Crustacés Décapodes Brachyours (Xanthidae) des campagnes de la Calypso en Mer Rouge (1952), dans le Golfe Persique et à l'île Aldabra (1954). *Mémoires du Muséum national d'Histoire naturelle*, Paris, (A) 32(1): i-iii, 1-108, figs 1-57, pls 1-12.

- Guinot, D., 1967. La faune carcinologique (Crustacea Brachyura) de l'Océan Indien Occidental et de la Mer Rouge: Catalogue, remarques biogéographiques et bibliographiques. In: Réunion de Spécialistes C.S.A. sur les Crustacés, Zanzibar 1964. *Mémoires de l'Institut fondamental d'Afrique Noire*, 77 (1966): 235-352, pls 1-26, 1 table.
- Guinot, D., 1969. Sur divers Xanthidae notamment sur *Actaea* de Haan et *Paractaea* gen. nov. (Crustacea Decapoda Brachyura). *Cahiers du Pacifique*, 13: 223-267, figs 1-36.
- Guinot, D., 1971. Recherches préliminaires sur les groupements naturels chez les Crustacés Décapodes Brachyours. VIII. Synthèse et bibliographie. *Bulletin du Muséum national d'Histoire naturelle Paris, Deuxième Série* 42: 1063-1090.
- Guinot, D., 1976. Constitution de quelques groupes naturels chez les Crustacés Décapodes Brachyours. I. La superfamille des Bellioidea et trois sous-familles de Xanthoidae (Polydectinae Dana, Trichiinae De Haan, Actaeinae Alcock). *Mémoires du Muséum National d'Histoire Naturelle*, Paris, ser. A (Zoologie) 97: 1-308, pls 301-319.
- Guinot, D., 1979. Données nouvelles sur la morphologie, la phylogénèse et la taxonomie des Crustacés Décapodes Brachyours. *Mémoires du Muséum national d'Histoire naturelle*, Paris, (Zoologie), 112: 1-354, figs 1-70, pls 1-27, 5 tables.
- Guinot, D., 1978. Principes d'une classification évolutive des Crustacés Décapodes Brachyours. *Bulletin Biologique de la France et de la Belgique* 112: 211-292.
- Hale, H.M., 1927. *The crustaceans of South Australia. Part I*. South Australian Government Printer: Adelaide. 201 pp.
- Heller, C., 1862. Neue Crustaceen, gesammelt während der Weltumseglung der k.k. Fregatte *Novara*. Zweiter vorläufiger Bericht. *Verhandlungen der kaiserlich-königlichen zoologisch-botanischen Gesellschaft in Wien*, 12: 519-528.
- Heller, C., 1863. Die Crustaceen des südlichen Europa. Crustacea Podophthalmia. Mit einer Übersicht über die horizontale Verbreitung sämtlicher europäischer Arten: i-xi, 1-336, pls 1-10.
- Heller, C., 1865. Die Crustaceen. 1. In: Reise der österreichischen Fregatte *Novara* um die Erde in den Jahren 1857-1859 unter den Befehlen des Commodors B. von Willerstorff-Urbair, Zoologischer Theil, 2(pt. 3): 1-280, pls 1-25.
- Henderson, J.R., 1893. A contribution to Indian Carcinology. *The Transactions of the Linnean Society of London*, (series 2, Zoology) 5(1): 325-458, pls 36-40.
- Herbst, J.F.W., 1801. Versuch einer Naturgeschichte der Krabben und Krebse nebst einer systematischen Beschreibung ihrer verschiedenen Arten, 3(2): 1-46, pls 51-54.
- Hess, W., 1865. *Beiträge zur kenntniß der decapoden-krebse ost-australiens*. Druck von Carl Georgi.
- Hilgendorf, F., 1879. Die von Hr. W. Peters in Moçambique gesammelten Crustaceen. *Monatsberichte der Königlich Akademie der Wissenschaften zu Berlin, Physikalisch-mathematische Klasse* 1878: 782-851, 732 pls.
- Hoffmann, C.K., 1874. Crustacés et Echinodermes de Madagascar et de l'île de la Réunion. In: Pollen, F.P.L. et D.C. van Dam, Recherches sur la faune de Madagascar et de ses dépendances d'après les découvertes de François, 5(2): 1-58, pls 1-10.
- Holthuis, L.B., 1953. Enumeration of the Decapod and Stomatopod Crustacea from Pacific Coral Islands. *Atoll Research Bulletin*, 24: 1-66, 2 maps. Mimeogr.
- Jeng, M.-S., 1997. Studies on the land and aquatic decapod crustacean fauna of the Kenting National Park (II) Communities of decapod crustaceans around the sea. ii+66 pp. Ministry of the Interior, Taipei.
- Kensley, B., 1981. On the zoogeography of southern African decapod Crustacea, with a distributional checklist of the species. *Smithsonian Contribution to Zoology*, 338: 1-64, figs 1-4, tables 1-2.
- Klunzinger, C.B., 1913. Die Rundkrabben (Cyclometopa) des Roten Meeres. *Abhandlungen der kaiserlich Leop.-Carol. Deutschen Akademie der Naturforscher Halle*, 99(2): 97-402, figs 1-4, pls 5-11.
- Kossmann, R., 1877. Zoologische Ergebnisse einer Reise in die küstengebiete des Rothen Meeres. Malacostraca. 1. Theil: Brachyura. Leipzig, W. Engelmann: 1-66, pls 1-3.
- Lai, J. C., Mendoza, J. C. E., Guinot, D., Clark, P. F., and Ng, P. K. 2011. Xanthidae MacLeay, 1838 (Decapoda: Brachyura: Xanthoidea) systematics: a multi-gene approach with support from adult and zoeal morphology. *Zoologischer Anzeiger-A Journal of Comparative Zoology*, 250(4), 407-448.
- Lanchester, W.F., 1900. On a collection of Crustaceans made at Singapore and Malacca. Part I. Crustacea Brachyura. *Proceedings of the Zoological Society of London*, 48(1): 719-770, pls 44-47.
- Laurie, R.D., 1906. Report on the Brachyura collected by Professor Herdman, at Ceylon, in 1902. In: W.A. Herdman, Report to the Government of Ceylon on the Pearl Oyster Fisheries of the Gulf of Manaar with supplementary reports upon the Marine Biology of Ceylon by other Naturalists, part 5, suppl. Rep. 40: 349-432, figs 1-12, pls 1-2.
- Legall N., and J. Poupin, Internet - CRUSTA: Database of Crustacea (Decapoda and Stomatopoda), with special interest for those collected in French overseas territories. At <http://crustiesfroverseas.free.fr/>.
- Lin, C.C., 1949. A catalogue of Brachyurous Crustacea of Taiwan. *Quarterly Journal of the Taiwan Museum*, 2(1): 10-33.
- Man, J.G. de, 1880. On some podophthalmous Crustacea, presented to the Leyden Museum by Mr. J. A. Kruyt, collected in the Red Sea near the city of Djeddah. *Notes from the Leyden Museum*, 2(21): 171-185. [1880/VII]
- Man, J.G. de, 1881. On a new collection of podophthalmous Crustacea, presented by Mr. J. A. Kruyt, collected in the Red Sea near the town of Djeddah. *Notes from the Leyden Museum*, 3(25): 93-107.
- Man, J.G. de, 1887. Bericht über die von Herrn. Dr. J. Brock im indischen Archipel gesammelten Decapoden und Stomatopoden. *Archiv für Naturgeschichte*, Berlin, 53(1): 215-288, pls 7-10.
- Man, J.G. de, 1895. Bericht über die von Herrn Schiffscapitän Storm zu Atjeh, an den westlichen Küsten von Malakka, Borneo und Celebes sowie in der Java-See gesammelten Decapoden und Stomatopoden. (In 6 parts). *Zoologische Jahrbücher*, Abteilung für Systematik, Geographie und Biologie der Thiere. Vol. 8(Teil 1): 485-609, figs 1-15, pls 12-14. [1895/VII]
- Man, J.G. de, 1902. Die von Herrn Professor Kükenthal im indischen Archipel gesammelten Dekapoden und Stomatopoden. In: W. Kükenthal, Ergebnisse einer zoologischen Forschungsreise in den Molukken und Borneo, in Aufträge der Senckenberg. Naturforsch. Gesellschaft ausgeführt von Dr. Willy Kükenthal. *Abhandlungen der Senckenbergischen naturforschenden Gesellschaft*, 25(3): 465-929, pls 19-27.
- Man, J.G. de, 1929a. Decapoda and Stomatopoda from Pulau Berhala. *Misc. Zool. Sumatra*, Medan, 36: 1-3.
- Man, J.G. de, 1929b. On a collection of Decapod and Stomatopod Crustacea from Pulau Berhala, an islet situated in the Straits of Malacca. *Bijdragen tot de Dierkunde*, 26: 1-26, pls 1-3.
- Martin, J.W., 1988. Phylogenetic significance of the brachyuran megalopa: evidence from the Xanthidae. *Symposia of the Zoological Society of London* 59: 69-102.
- McNeill, F.A., 1968. Crustacea, Decapoda and Stomatopoda. *Scientific Reports Great Barrier Reef Expedition 1928-29*, 7(1): 1-98, figs 1-2, pls 1-2.
- Michel, C., 1964. Checklist of the Crustacea Brachyura (Crabs) recorded from Mauritius. *Mauritius Institute Bulletin*, 6(1): 1-48.

- Miers, E.J., 1884. Crustacea (Brachyura). In: Report on the Zoological Collections made in the Indo-Pacific Ocean during the Voyage of H.M.S. *Alert* 1881-1882. Part I. The collections from Melanesia. Part II. The collections from the Western Indian Ocean. British Museum (Natural History), London, 8(2): 513-575, pls 46-52.
- Miers, E.J., 1886. Report on the Brachyura collected by H.M.S. *Challenger* during the years 1873-1876. In: C.W. Thompson & J. Murray, *Report on the Scientific Results of the exploring Voyage of H.M.S. Challenger during the years 1873-1876, under the command of Captain George S. Nares, R.N., F.R.S. and the Late Captain Frank Tourle Thomson, R.N.*, Zoology, 17(2): i-xli, 1-362, pls 1-29. Michel, C., 1964. Checklist of the Crustacea Brachyura (Crabs) recorded from Mauritius. *Mauritius Institute Bulletin*, 6(1): 1-48.
- Milne-Edwards, A., 1862. Faune carcinologique de l'île de la Réunion. In: L. Maillard, Notes sur l'île de la Réunion (Bourbon), Paris. Annexe F de l'ouvrage intitulé: F1-F16, pls 17-19.
- Milne-Edwards, A., 1865. Études zoologiques sur les Crustacés récents de la famille des Cancriniens. Cancriniens, Pirmélides, Carpilides, Première Partie. *Nouvelles Archives du Muséum national d'Histoire naturelle*, Paris, 1: 177-308, pls 11-19.
- Milne-Edwards, A., 1873. Recherches sur la faune carcinologique de la Nouvelle-Calédonie. Part II. Groupe des Cyclométopes Portuniens. *Nouvelles archives du Muséum national d'Histoire naturelle*, Paris, 9: 155-332, pls 4-18.
- Milne-Edwards, H., 1834. Histoire Naturelle des Crustacés, comprenant l'anatomie, la physiologie et la classification de ces animaux. Librairie Encyclopédique de Roret, Paris, Vol. 1: i-xxxv, 1-468, pls 3, 5-6, 15-17, 20, 22-23, 25.
- Miyake, S., 1938. Unrecorded crabs from Formosa collected by Prof. Hiroshi Ohshima in 1932. Transactions of the Natural History Society of Formosa, 28(177): 187-196, figs 1-4. (In Japanese)
- Miyake, S., 1983. Japanese Crustacean Decapods and Stomatopods in color. Vol. II. Brachyura (Crabs), i-viii, 1-277, pls 1-64. Hoikusha, Osaka. (In Japanese; second edition in 1992)
- Monod, T., 1938. Dacapoda Brachyura. In: Mission Robert Ph. Dollfus en Egypte. VIII. *Mem. Inst. Egypte*, 37: 91-162, fig. 1-29.
- Montgomery, S.K., 1931. Report on the Crustacea Brachyura of the Percy Sladen Trust expedition to the Abrolhos Islands under the leadership of Prof. W.J. Dakin in 1913, along with other crabs from Western Australia. *Journal of the Linnean Society of London (Zoology)* 37: 405-464, pls 424-430.
- Morgan, G. J. 1990. A collection of *Thalassinidea*, *Anomura* and *Brachyura* (Crustacea: Decapoda) from the Kimberley region of northwestern Australia. Nationaal Natuurhistorisch Museum.
- Muraoka, K., 1998. Catalogue of the Brachyuran and Anomuran Crabs donated by Prof. Dr. Tane Sakai to the Kanagawa Prefectural Museum. *Catalogue of the Collection in the Kanagawa Prefectural Museum of Natural History*, 11: 5-67, pls 1-16.
- NERP National Environment Research Program (2012). <http://www.nerpmarine.edu.au/rv-solander-blog>
- Ng, P.K., 1993. On a new genus and species of xanthid crab (Crustacea: Decapoda: Brachyura) from Chesterfield Island, Coral Sea. *Proceedings Biological Society of Washington* 106: 705-705.
- Ng, P.K., 2002. On a new species of cavernicolous Neoliomera (Crustacea: Decapoda: Brachyura: Xanthidae) from Christmas Island and Ryukyu, Japan. *Raffles Bulletin of Zoology* 50: 95-100.
- Ng, P.K.L., and Clark, P.F. 2003. Three new genera of Indo-West Pacific Xanthidae (Crustacea, Decapoda, Brachyura, Xanthoidea). *Zoosystema* 25: 131-147.
- Ng, P.K.L., Guinot, D., and Davie, P.J.F. 2008. Systema Brachyurorum; Part I. An annotated checklist of extant brachyuran crabs of the world. *Raffles Bulletin of Zoology* 17: 1-286.
- Nichol, S.L., Howard, F.J.F., Kool, J., Stowar, M., Bouchet, P., Radke, L., Siwabessy, J., Przeslawski, R., Picard, K., Alvarez de Glasby, B., Colquhoun, J., Letessier, T. & Heyward, A. 2013. *Oceanic Shoals Commonwealth Marine Reserve (Timor Sea) Biodiversity Survey: GA0339/SOL5650 – Post Survey Report*. Record 2013/38. Geoscience Australia: Canberra.
- Nobili, G., 1906a. Faune carcinologique de la Mer Rouge. Décapodes et stomatopodes. *Annales des Sciences Naturelles* 4: 1-347, pls 341-311.
- Nobili, M.G., 1906b. Faune carcinologique de la Mer Rouge. Décapodes et Stomatopodes. *Annales des Sciences naturelles*, Zoologie, (9) 4(1-3): 1-347, figs 1-12, pls 1-11.
- Odhner, T., 1925. Monographierte Gattungen der Krabben-familie Xanthidae. I. *Göteborgs Kungliga Vetenskaps- och Vitterhets-Samhälles Handlingar*, (4) 29(1): 1-92, figs 1-7, pls 1-5.
- Ortmann, A.E., 1893. Die Decapoden-Krebse des Strassburger Museums, mit besonderer Berücksichtigung der von Herrn Dr. Döderlein bei Japan und bei den Liu-Kiu-Inseln gesammelten und zur Zeit im Strassburger Museum aufbewahrten Formen. Teil VII. Abteilung Brachyura (Brachyura genuina Boas), III. Unterabteilung: Cancroidea, 2. Section: Cancrinea, 1. Gruppe: Cyclometopa. *Zoologische Jahrbücher. Abteilung für Systematik, Geographie und Biologie der Thiere*, 7: 411-495, pl. 17.
- Ortmann, A.E., 1894. Die Decapoden-Krebse des Strassburger Museums, mit besonderer Berücksichtigung der von Herrn Dr. Döderlein bei Japan und bei den Liu-Kiu-Inseln gesammelten und zur Zeit im Strassburger Museum aufbewahrten Formen. VIII. Thiel. Abtheilung: Brachyura (Brachyura genuina Boas), III. Unterabtheilung: Cancroidea, 2. Section: Cancrinea, 2. Gruppe: Catametopa. *Zoologische Jahrbücher. Abteilung für Systematik, Geographie und Biologie der Thiere* 7(5): 683-772, Plate 23.
- Ortmann, A.E., 1894b. Decapoden. In: R. Semon (ed.), *Zoologische Forschungsreisen in Australien und dem Malayischen Archipel ausgeführt in den Jahren 1891-93. V. Denkschriften der medizinisch-naturwissenschaftlichen Gesellschaft*, Jena, 8: 1-80, pls 1-13.
- Poore, G.C.B., 2004. *Marine decapod Crustacea of southern Australia. A guide to identification (with chapter on Stomatopoda by Shane Ahlyong)*. CSIRO Publishing: Melbourne. 574 pp.
- Poore, G., McCallum, A., and Taylor, J. 2008. Decapod Crustacea of the continental margin of southwestern and central Western Australia: preliminary identifications of 524 species from FRV *Southern Surveyor* voyage SS10-2005. *Museum Victoria Science Reports* 11: 1-106.
- Przeslawski, R., Alvarez de Glasby, B., Smit, N., Evans-Illidge, L., Dethmers, K. 2013. Benthic Biota of Northern Australia: SS2012t07 Post-survey Report. Record 2013/07. *Geoscience Australia*: Canberra.
- Rathbun, M.J., 1906. The Brachyura and Macrura of the Hawaiian Islands. *Bulletin of the United States Fish Commission*, 23(3): i-viii, 827-930, figs 1-79, pls 1-24.
- Rathbun, M.J., 1907. Reports on the Scientific Results of the Expedition to the Tropical Pacific, in charge of Alexander Agassiz, by the U.S. Fish Commission Steamer *Albatross*, from August, 1899 to March, 1900, Commander Jefferson F. Moser, U.S.N., commanding - IX. Reports on the scientific results of the expedition to the eastern tropical Pacific, in charge of Alexander Agassiz, by the U.S. Commission Steamer *Albatross* from October, 1904 to March, 1905, lieutenant-commander L.M. Garrett, U.S.N., commanding - X. The Brachyura. *Memoirs of the Museum of Comparative Zoology at Harvard College*, 35(2): 23-74, pls 1-9.
- Rathbun, M.J., 1910. The Brachyura. In: The Danish Expedition to Siam, 1899-1900. V. *Kongelige Danske Videnskabernes Selskabs Skrifter*, Kjøbenhavn, (7) 5(4): 301-367, figs 1-44, pls 1-2, 1 map.

- Rathbun, M.J., 1911. Marine Brachyura. In: The Percy Sladen Trust Expedition to the Indian Ocean in 1905, under the Leadership of Mr J. Stanley Gardiner. Vol. III, part II, No. XI. *Transactions of the Linnean Society of London*, (Zool.), (2) 14(2): 191-261, figs 1-2, pls 15-20.
- Rathbun, M.J., 1923. Report on the crabs obtained by the F.I.S. "Endeavour" on the coasts of Queensland, New South Wales, Victoria, South Australia and Tasmania. Report on the Brachyrhyncha, Oxystomata and Dromiacea. *Biological Results of the Fishing Experiments carried out by the F.I.S. "Endeavour", 1909-14* 5: 95-156, pls 116-142.
- Rathbun, M. J. 1924. Results of Dr. E. Mjöberg's Swedish scientific expeditions to Australia 1910-1913. 37. Brachyura, Albuneidae and Porcellanidae. *Arkiv för Zoologi*, 16(23): 1-33.
- Ribes, S., 1978. La Macrofaune vagile associée à la partie vivante des Scléractiniaires sur un récif frangeant de l'Ile de la Réunion (océan Indien). Thèse de doctorat, Océanologie, Univ. Aix-Marseille II: 1-167, fig. 1-28.
- Richters, F., 1880. Decapoda. In: K. Möbius, Beiträge zur Meeresfauna der Insel Mauritius und der Seychellen, bearbeitet von K. Möbius, F. Richters und E. von Martens nach sammlungen, angelegt auf einer Reise nach Mauritius von K. Möbius, Berlin: 139-178, pls 15-18.
- Sakai, K., 1999. J.F.W. Herbst - collection of Decapod Crustacea of the Berlin Zoologica Museum, with remarks on certain species. *Naturalists*, Publications of Tokushima Biological Laboratory, Shikoku University, 6: 1-45, pls 1-21.
- Sakai, T., 1939. Studies on the crabs of Japan. IV. Brachygnatha, Brachyrhyncha, pp. 365-741, figs 1-129, pls 42-111, table 1. Yokendo Co., Tokyo.
- Sakai, T., 1965a. Notes from the Carcinological Fauna of Japan. (II). *Researches on Crustacea*, 2: 37-46, figs 1-2, pls 5-6, frontispieces 2-3. (In Japanese and English).
- Sakai, T., 1965b. The Crabs of Sagami Bay, collected by His Majesty the Emperor of Japan, i-xvi, 1-206 (English text), figs 1-27, pls 1-100: 1-92 (Japanese text): 1-26 (references and index in English): 27-32 (index in Japanese), 1 map. Maruzen Co., Tokyo.
- Sakai, T., 1976. Crabs of Japan and the Adjacent Seas. (In 3 volumes: (1) English text: i-xxix, 1-773, figs 1-379, (2) Plates volume: 1-16, pls 1-251, (3) Japanese text: 1-461, figs 1-2, 3 maps.) Kodansha Ltd, Tokyo.
- Sankarankutty, C., 1966. On Brachyura collected during cruise of U.S. Research Vessel *Anton Bruun*. *Journal of the zoological Society of India*, Calcutta, 16(1-2): 48-52, figs 1-2.
- Serène, R., and N.V. Luom, 1960. Les espèces de *Carpilodes* (Bachyura-Xanthidae) du Viet-Nam. *Annales de la Faculté des Sciences, Université de Saigon*, 1960: 173-187, figs 1-2, pls 1-2.
- Serène, R., 1968. The Brachyura of the Indo-West Pacific region. In: Prodomus for a check list of the non-planctonic marine fauna of South East Asia. UNESCO Singapore National Academy of Sciences, Special publication No. 1, Fauna IIIC3: 33-112.
- Serène, R., 1972. On the Brachyuran fauna of the Indo-Pacific coral reefs. *Proc Sym Corals Coral Reefs. Marine Biological Association of India, Cochín*: 419-425.
- Serène, R., 1977. Crustacés hippidés et brachyours des îles Séchelles (1ère partie). *Revue de Zoologie Africaine*, Tervuren, 91(1): 45-68, figs 1-38.
- Serène, R., 1984. Crustacés Décapodes Brachyours de l'Océan Indien occidental et de la Mer Rouge, Xanthoidea: Xanthidae et Trapeziidae. Avec un addendum par Crosnier (A): Carpiliidae et Menippidae. Faune Tropicale, no. XXIV: 1-349, figs A-C + 1-243, pls 1-48. (Translated into English by R.W. Ingle).
- Targioni Tozzetti, A., 1877. Crostacei Brachyuri e Anomuri. In: Zoologia del viaggio intorno al Globo della R. Pirocorvetta *Magenta* durante gli anni 1865-1868. *Pubblicazioni del R. Istituto di Studi superiore pratici e di Perfezionamento in Firenze. Sezione di Scienze fisiche e naturali*, 1: i-xxix, 1-257, pls 1-12.
- Thoma, B. P., Guinot, D., and Felder, D. L. 2014. Evolutionary relationships among American mud crabs (Crustacea: Decapoda: Brachyura: Xanthoidea) inferred from nuclear and mitochondrial markers, with comments on adult morphology. *Zoological Journal of the Linnean Society*, 170(1), 86-109.
- Tweedie, M.W.F., 1950. The fauna of the Cocos-Keeling Islands. Brachyura and Stomatopoda. Bulletin of the Raffles Museum, Singapore, 22: 105-148, figs 1-4, pls 16-17.
- Ward, M., 1933a. The true crabs of the Capricorn Group, Queensland. *Australian Zoologist* 7: 237-255.
- Ward, M., 1933b. New genera and species of marine Decapoda Brachyura from the coasts of New South Wales and Queensland. *Australian Zoologist* 7: 377-394, pls 321-323.
- Ward, M., 1934. Notes on a collection of crabs from Christmas Island, Indian Ocean. *Bulletin of the Raffles Museum* 9: 5-28.
- Ward, M., 1936. Crustacea Brachyura from the coasts of Queensland. *Memoirs of the Queensland Museum* 11: 1-3.
- Ward, M., 1942. Notes on the Crustacea of the Desjardins Museum, Mauritius Institute, with descriptions of new genera and species. *Bulletin of the Mauritius Institute*, Port Louis, 2(2): 49-113, pls 5-6.
- White, A., 1848. Short Descriptions of new or little-known Decapod Crustacea. *Proceedings of the Zoological Society of London*, 15(pt. 15, no.79) (1847): 222-228, 2 figs.
- White, A., 1847. Short descriptions of some new species of Crustacea in the collection of the British Museum. *Annals and Magazine of Natural History* 20: 205-207.
- Whitelegge, T., 1897. The Crustacea of Funafuti. In: The Atoll of Funafuti, Ellice Group: its Zoology, Botany, Ethnology, and General Structure based on Collections made by Mr. Charles Hedley, of the Australian Museum, Sydney, N.S.W. *Australian Museum Memoirs*, 3(2): 125-151, pls 6-7.
- Yokoya, Y., 1933. On the Distribution of Decapod Crustaceans inhabiting the Continental Shelf around Japan, chiefly based upon the Materials collected by S.S. Sôyô-Maru, during the years 1923-1930. *Journal of the College of Agriculture, Tokyo Imperial University*, 12(1): 1-226, figs 1-71, tables 1-4.
- Yu, H.-P., M.-S. Jeng, T.-Y. Chan, P.-H. Ho & J.-Y. Shy, 1996. Studies on the land and aquatic decapod crustacean fauna of the Kenting National Park. ii+79 pp. Ministry of the Interior, Taipei. (in Chinese with English abstract)

***Halearcturus*, a new genus of Antarcturidae Poore, 2001 (Crustacea: Isopoda: Valvifera) with a key to genera of the family**

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Abstract

Poore, G.C.B. 2015. *Halearcturus*, a new genus of Antarcturidae Poore, 2001 (Crustacea: Isopoda: Valvifera) with a key to genera of the family. *Memoirs of Museum Victoria* 73: 13–18.

A new genus *Halearcturus* is erected for a single species, *Arcturus serrulatus* Whitelegge, 1904. It differs from all other antarcturid genera in the combination of having an antennal flagellum of one major article plus a short curved tapering article (all other genera have either three or four articles, or about nine, plus a terminal one) and is unusual in lacking a uropodal exopod. *Halearcturus* has unique complex ornamentation; it lacks both a strong medial posterior spine and a pair of prominent sublateral spines on the pleotelson, typical of other antarcturids. The genus has a single species from south-eastern Australia. A key to genera of Antarcturidae is presented.

Keywords

Crustacea; Isopoda; Valvifera; Antarcturidae; *Halearcturus*; new genus; key

Introduction

The family Antarcturidae Poore, 2001 includes over 120 species, many presently or formerly included in the genus *Antarcturus* zur Strassen, 1902 (Schotte et al., 2008 onwards). Brandt (1990) revised *Antarcturus*, erecting five similar new genera. The number of genera in Antarcturidae has grown since then to eighteen. Nevertheless, generic differentiation remains problematic. No phylogeny exists, the characters used to differentiate genera remain unclear, several species are difficult to place, several species are undescribed (especially in southern Australia), and nomenclatural issues remain.

Compounding the problems are 41 species that have been described or included later in the genus '*Microarcturus* Nordenstam, 1933'. This name is a nomen nudum (Poore, 2001). Poore (2003) allocated most of these to other genera in Antarcturidae Poore, 2001, Austrarcturellidae Poore and Bardsley, 1992, Holidoteidae Wägele, 1989, or Pseudidotheidae Ohlin, 1901 but two were said to belong to new genera. This contribution deals with one of these by erecting a new monotypic genus.

Arcturus serrulatus Whitelegge, 1904 is an easily recognised southern Australian species on account of its unique decoration of prominent plate-like projections. It was included in *Antarcturus* by Stebbing (1908) and placed in *Microarcturus* by Nordenstam (1933). The species was redescribed and illustrated more fully by Hale (1946) but remains in taxonomic limbo. This opportunity is taken to present an interim key to genera currently included in

Antarcturidae. The most recent key dealt with only few Antarctic genera in the context of the arcturid subfamily Arcturinae (Wägele, 1991).

Material is deposited in the Australian Museum, Sydney (AM) and Museum Victoria, Melbourne (NMV).

Key to genera of Antarcturidae Poore, 2001

1. Pereopods 2–4 bearing few well spaced straight stiff setae along flexor margins of carpus to propodus; body and limbs covered with fine short setae 2
- Pereopods 2–4 bearing numerous closely and regularly spaced fine 'filter setae' along flexor margins of at least merus to propodus; body and limbs smooth 3
2. Pereonal and pleonal segments each with pair of dorsolateral spines of similar lengths; eyes unpigmented
..... *Thermoarcturus* Paul & Menzies, 1971
- Pleotelson with 1 pair of dorsolateral spines much longer than others; eyes pigmented
..... *Spinarcturus* Kensley, 1978
3. Antenna flagellum of 9 or more short articles 4
- Antenna flagellum of 4 or fewer short articles 9
4. Pleonite 1 free from remaining segments of pleotelson 5
- Pleonite 1 fused to remaining segments of pleotelson 7

5. Pleonites 5 and 6 with middorsal spines *Marmachius* Poore, 2012
 – Pleonites without middorsal spines 6
6. Head without pair of spines between eyes, pereon and pleon without submedian, sublateral and supracoxal spines; pleotelson without prominent medial posterior spine dorsal to margin *Furcarcturus* Baltzer, Held and Wägele, 2000
 – Head with pair of spines between eyes, pereon and pleon with pairs of submedian, sublateral and supracoxal spines; pleotelson with prominent medial posterior spine dorsal to margin *Oxyarcturus* Brandt, 1990
7. Pleotelson with paired submedian spines or tubercles, with marginal lateral spines *Antarcturus* zur Strassen, 1902
 – Pleotelson without paired submedian spines or tubercles, without marginal lateral spines 8
8. Head without pair of submedian spines between eyes; pereonites without middorsal, sublateral or supracoxal spines (tubercles at most) *Litarcturus* Brandt, 1990
 – Head with pair of submedian spines between eyes; pereonites with sublateral and supracoxal mushroom-like tubercles; pereonites 1–4 with middorsal tubercles on posterior margins *Tuberarcturus* Brandt, 1990
9. Pleonites without middorsal spines 10
 – One or more pleonites with middorsal spines or tubercles 17
10. Head with pair of submedian spines 11
 – Head without pair of submedian spines 15
11. Eyes absent 12
 – Eyes present, pigmented 13
12. Pereonites with paired submedian and sublateral tubercles; pereopods 2–4 with regular rows of long setae along flexor margins of merus–propodus, unguis setiform *Abyssarcturus* Kussakin and Vasina, 1995
 – Pereonites without paired submedian and sublateral spines; pereopods 2–4 with regular rows of long setae along flexor margins of merus–dactylus, unguis short, curved *Glaberarcturus* Kussakin and Vasina 1998
13. Pleotelson with paired submedian and lateral spines, with prominent paired posterior sublateral spines *Fissarcturus* Brandt, 1990
 – Pleotelson with prominent medial posterior spine dorsal to margin or apex prominently produced 14
14. Pereopods 2–4 with regular rows of long setae along flexor margins of merus–propodus *Acantharcturus* Schultz, 1981
 – Pereopods 2–4 with regular rows of long setae along flexor margins of merus–dactylus *Chaetarcturus* Brandt, 1990
15. Pleotelson without pairs of sublateral spines 16
 – Pleotelson with prominent pair of sublateral spines near midpoint *Caecarcturus* Schultz, 1981
16. Eyes pigmented; pleotelson dorsal surface convex, not differentiated from lateral margin, with medial spine prominently posteriorly produced *Cylindarcturus* Schultz, 1981
 – Eyes absent; pleotelson dorsal surface bulbous, differentiated from lateral margin by longitudinal groove, without prominent medial posterior spine *Globarcturus* Kussakin and Vasina, 1994
17. Pleotelson with 2 middorsal tubercles near apex, with paired submedian and sublateral spines *Halarcturus* gen. nov.
 – Pleonites 2 and 3 with middorsal spine; pleotelson without pairs of submedian and sublateral spines 18
18. All pereonites with paired sublateral tubercles and supracoxal spines; pleotelson with prominent paired posterior sublateral spines; pereopods 2–4 with unguis short, curved *Mixarcturus* Brandt, 1990
 – Pereonites without paired sublateral spines or supracoxal spines; pleotelson without prominent paired posterior sublateral spines more dominant than other spines; pereopods 2–4 unguis setiform *Pleuoprion* zur Strassen, 1903

Halarcturus gen. nov.

Zoobank LSID. <http://zoobank.org/urn:lsid:zoobank.org:act:80AB03F2-0DAD-4205-9831-B8F30D3D0757>

Type species. *Arcturus serrulatus* Whitelegge, 1904, by monotypy and original designation (masculine).

Diagnosis. Body weakly geniculate between pereonites 4 and 5, anterior pereon slightly elevated. Head with pair of submedian spines between eyes; pereonites with supracoxal spines on all pereonites, with paired sublateral tubercles, without paired submedian spines, without middorsal spines; pleonite 1 fused to remaining pleotelson; pleotelson with 2 middorsal tubercles near apex, without paired submedian spines, with pairs of sublateral tubercles, with marginal lateral projections, without prominent paired posterior sublateral spines more dominant than other spines, without prominent medial posterior spine dorsal to margin. Antennal flagellum of 2 articles, first about third as long as peduncle article 5, second quarter length of first. Pereopods 2–4 with regular row of long setae along flexor margins of merus–propodus, second row on mesial face. Pereopods 2–4 unguis short, curved. Pleopod 1 of male exopod groove opening distolaterally on margin, scarcely produced at opening. Pleopod 2 of male, appendix masculina acute, at least 1.5 times as long as endopod. Uropod without exopod.

Oostegites 2–4 supported by ventral coxal processes, largest on pereonite 4; oostegite 5 absent, without ventral coxal processes.

Etymology. For Herbert Mathew Hale (1895–1963) whose contributions significantly expanded knowledge of marine isopods in southern Australia, combined with *Arcturus*, a commonly used genus stem.

Composition. Type species only.

Remarks. Several characters set this genus and its only species apart from other antarcturids. *Halearturus serrulatus* is unique in the family in having an antennal flagellum of one major article plus a short curved tapering second article; all other genera have either three or four articles, or about nine of similar lengths, plus a terminal one. The genus is unusual in lacking a uropodal exopod but may not be unique in this regard. The exopod is absent also in '*Microarcturus*' *digitatus* Nordenstam, 1933, now accepted as *Mixarcturus digitatus* (Nordenstam, 1933) (Poore, 2003), but not in *M. abnormis* (Kussakin, 1967), type species of the genus. The exopod was said to be absent in *Antarcturus usitatus* Schultz, 1978 although it is present in all other species of the genus.

Halearturus has unique complex ornamentation of plate-like tubercles and lacks both a strong medial posterior spine and a pair of prominent sublateral spines on the pleotelson. *Abyssarcturus* Kussakin & Vasina, 1995, *Globarcturus* Kussakin & Vasina, 1994 and *Tuberarcturus* Brandt, 1990 (and some members of the loosely defined *Fissarcturus* Brandt, 1990) share this pleotelsonic spination but all three have very different patterns of body ornamentation. *Abyssarcturus* and *Globarcturus* lack pigmented eyes and have a 4-articled antennal flagellum. *Abyssarcturus* has a setiform unguis on pereopods 2–4. *Tuberarcturus* has middorsal tubercles on the posterior margins of pereonites 1–4 and a 9-articled antennal flagellum. *Spinarcturus* Kensley, 1978 and *Thermoarcturus* Paul & Menzies, 1971 have simple pleotelsonic sculpture but both genera (one species each) are covered with a mat of fine setae and lack the pairs of long 'filter-setae' on pereopods 2–4 (Wägele, 1987) which are usual in Antarcturidae.

Halearturus serrulatus (Whitelegge, 1904)

Fig. 1

Arcturus serrulatus Whitelegge, 1904: 414–416, figs 118a–c.

Antarcturus serrulatus.—Stebbing, 1908: 53.

Microarcturus serrulatus.—Nordenstam, 1933:128.—Nierstrasz, 1941: 261.—Hale, 1946: 200–202, figs 23, 24.

Type locality. Australia, NSW, off Wattamolla [as Wata Mooli], 99–108 m (HMCS *Thetis* stn 57) (type material lost).

Figured specimens. Bass Strait, 70 km SW of Cape Otway, 39°26.60'S, 143°6.8'E, 115 m, NMV J8593 (male, 6.7 mm). 8 km S of South East Point, Wilsons Promontory, 39°13.80'S, 146°27.3'E, 65 m, NMV J62821 (ovigerous female, 10.0 mm).

Other material examined. NSW, off mouth of Manning River, 31°55'S, 152°52'E, AM P.11752. 25–28 km NE of South Head, Port Jackson, 33°44'S, 151°38'E, AM P.11671. Jervis Bay, 35°3'S, 150°44'E, AM G.940. 22.4 km off Batemans Bay, 35°45'S, 150°30'E, AM P.10715.

Bass Strait, Western Port and E of Tasmania: 43 specimens from Museum Victoria collections (see <http://museumvictoria.com.au/collections-research/our-collections/>).

Redescription. Ovigerous female, 10.0 mm. Head front, concave; with pair of anteriorly-directed curved blade-like projection between eyes; pair of tuberculate submedian bosses and pairs of small dorsolateral and lateral lobes on maxillipedal segment. Pereonites 1–4 each with pair of prominent submedian anteriorly-curved, hook-like projections, pair of smaller conical projections near posterior margin, pair of lateral anteriorly-directed projections each with small conical boss on anterior margin (lateral projection small on pereonite 1). Pereonites 5–7 each with pair of lateral flat-topped projections and much smaller cone near posterior margin. Pleonite 1 with pair of lateral posteriorly-directed. Pleonite 2 with pair of strong dorsolateral conical projections and smaller lateral posteriorly-directed cones. Pleonite 3 with low median boss, pair of smaller dorsolateral cones, pair of lateral wings directed posteriorly. Pleonites 4–6 and telson with 4 pairs of submedian conical tubercles, fourth largest, 3 sublateral conical tubercles, second largest, 3 pairs of lateral triangular tubercles, 1 median tubercles in front of apex, and apex with 1 dorsal median tubercle.

Coxa 1 fused to pereonite, with 3 triangular flat lobes. Coxae 2–4 free, each with 2 anterior and 2 posterior triangular flat lobes, the most posterior on pereopod 4 elongated as oostegite support. Coxae 5–7 fused, with lateral flat-topped tubercles and anterior and posterior triangular lobes.

Antennule flagellum blade-like, toothed; flagellum with 8 pairs of aesthetascs + 3 single subdistal aesthetascs. Antennal peduncle articles 2–4 laterally flattened, with teeth on upper margin.

Pereopod 2 basis with 2 teeth each on extensor and flexor margins; merus with small tooth at midpoint and large distal blade-like tooth on extensor margin; carpus with blade-like tooth at midpoint of extensor margin; propodus with 4 small teeth on extensor margin; dactylus with 2 small teeth on extensor margin, with short unguis. Pereopod 3 basis with 3 teeth on extensor and 6 on flexor margins; merus with distal blade-like tooth on extensor margin and small tooth on flexor margin; carpus with 2 blade-like teeth on extensor margin, small spine on flexor margin; propodus and dactylus as in pereopod 2. Pereopod 4 basis with 4 spines on extensor and 10 spines on flexor margin, irregularly arranged; ischium with spines on flexor margin; merus with distal blade-like tooth on extensor margin and small tooth on flexor margin; carpus with 2 blade-like teeth on extensor margin, small spine on flexor margin; propodus and dactylus as in pereopod 2.

Pereopod 5 with 4 tubercles on extensor margin, 3 on flexor margin; ischium irregularly tuberculate; merus and carpus each with 2 robust setae on conical projection on margin; propodus with 5 robust setae on conical projection on margin; dactylus curved. Pereopods 6 and 7 similar, less ornate, bases shorter.

Uropodal peduncle with 2 longitudinal-oblique rows of tubercles, 3 in row next to suture, 5 larger in midline; endopod triangular; exopod absent.

Sternite 8 simple flat, without oostegite.

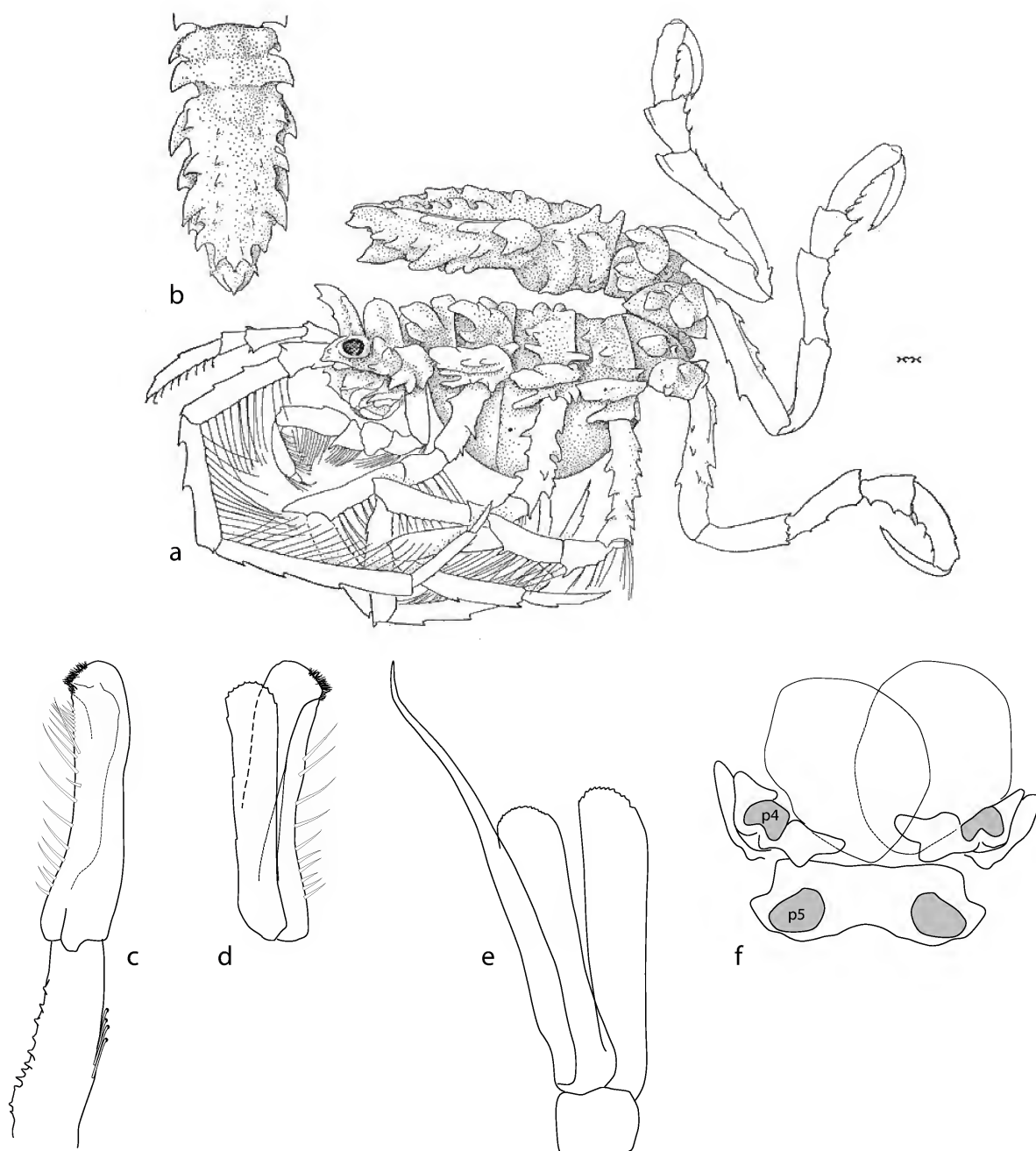


Figure 1. *Haelearturus serrulatus* (Whitelegge, 1904). a, female habitus; b, dorsal view of pleotelson. c, d, left male pleopod 1 in anterior and posterior views. e, left male pleopod 2 in posterior view. f, ventral view of coxae and oostegites of pereopods 4, sternum of pereonite 5 [a, b, reproduced from Hale (1946); c–e, NMV J8593; f, NMV J62821].

Male, 6.7 mm. Body more slender than ovigerous female, as typical of Antarcturidae. Head with pair of blade-like horns between eyes, each with acute tip and small acute point on anterior margin; pair of large submedian hemispherical bosses. Pereonites 2–4 each with pair of sublateral hook-like anteriorly-directed tubercles, pair of small tubercles near posterior lateral margin, pair of lateral marginal flat triangular lobes, directed anteriorly. Pereonites 5–7 each with pair of lateral conical tubercles. Pleonite 1 with pair of small lateral tubercles, with pair of sharp conical tubercles on sternum anterior to pleopods 1. Pleonite 2 with pair of large sublateral tubercles. Pleonite 3 with median boss. Remaining pleotelson with 2 pairs of obsolete submedian tubercles, 3 pairs of sublateral tubercles, second largest, 3 pairs of lateral wings, first largest, 1 median tubercles in front of apex, and apex with 1 dorsal median tubercle.

Coxae 1–4 unarmed. Coxae 5–7 each with obsolete anterior and posterior lateral tubercles.

Pereopod 2 merus with blade-like tooth on extensor margin; carpus with 2 blade-like teeth on extensor margin; propodus with 3 teeth on extensor margin; dactylus with 2 teeth on extensor margin. Pereopods 3 and 4 similar: basis with small marginal teeth; ischium with small tooth on flexor margin; merus with 1 blade-like tooth on extensor margin; carpus with 2 blade-like teeth on extensor margin, small spine on flexor margin; propodus and dactylus as in pereopod 2. Pereopods 5–7 similar: basis with irregular teeth; merus and carpus each with 2 robust setae on conical projection on margin; propodus with 4 robust setae on conical projection on margin; dactylus curved.

Pleopod 1 exopod with oblique groove opening laterally at about 90% of length, opening surrounded by dense setation, most distal part lamellar. Pleopod 2 endopod with tapering simple appendix masculina curving anteriorly, 1.6 times length of endopod.

Uropodal peduncle with 2 longitudinal-oblique rows of tubercles, 3 in row next to suture, 3 larger in midline.

Colour. Pale with small brown lateral spot on each segment of pereon and pleon and pereopodal coxa, 1 or 2 on each pereopodal basis, ischium, merus and carpus, 2 on uropod.

Size (total length). Largest male, 6.7 mm; largest ovigerous female, 10.0 mm.

Distribution. Southeastern coast of Australia and eastern Bass Strait, 32°S–43°S.

Remarks. The two syntypes are lost (Springthorpe and Lowry, 1994). Nevertheless, Whitelegge's (1904) description and his few drawings can be interpreted and reconciled with the abundant available material – the species is unmistakable and common in collections on the shelf of southeastern Australia. Sampling on the NSW shelf has been intensive, especially in the 1970s–1980s and no other antarcturid matches his description. Hale's (1946) description and more complete illustrations of material from Bass Strait are similarly unmistakable. His habitus drawing is reproduced here. The redescription above is limited to the body armature and to those features important in differentiation of antarcturid

genera: antenna, pereopodal dactyli, male pleopods 1 and 2, female sternite 8 and the uropod. Both Whitelegge and Hale illustrated and described ovigerous females. The diagnostic ornamentation can be discerned in a reduced form in specimens of all sizes.

Acknowledgements

Most of the material was collected during exploratory cruises in Bass Strait and the southeastern Australian slope supported by the former Marine Sciences and Technologies Scheme and the Australian Research Council. Early work on Isopoda Valvifera, of which this is part, was supported by grants from the Australian Biological Resources Study.

References

- Baltzer, C., Held, C., and Wägele, J.W. 2000. *Furcarcturus polarsterni* gen. nov., a large deep-sea arcturid isopod from the Drake Passage, with a preliminary molecular characterization. *Polar Biology* 23: 833–839.
- Brandt, A. 1990. *Antarctic valviferans (Crustacea, Isopoda, Valvifera) new genera, new species and redescrptions*. E.J. Brill: Leiden. 176 pp.
- Hale, H.M. 1946. Isopoda –Valvifera. *British, Australian and New Zealand Antarctic Research Expedition, 1929–1931. Reports-Series B (Zoology and Botany)* 5: 161–212.
- Kensley, B. 1978. The South African Museum's Meiring Naude cruises. Part 7. Marine Isopoda. *Annals of the South African Museum* 74: 125–157.
- Kussakin, O.G. 1967. Fauna of Isopoda and Tanaidacea in the coastal zones of the Antarctic and Subantarctic waters. [Translation from Russian by the Israel Program for Scientific Translations, Jerusalem, 1968.]. *Biological Reports of the Soviet Antarctic Expedition (1955–1958)* 3: 220–389.
- Kussakin, O.G., and Vasina, G.S. 1994. Description of *Globarcturus angelikae* gen. et sp. n., the first Antarctic hadal arcturid from the South Sandwich Trench (Crustacea, Isopoda: Arcturidae). *Zoosystematica Rossica* 2: 241–245.
- Kussakin, O.G., and Vasina, G.S. 1995. Antarctic hadal arcturids, with descriptions of a new genus and five new species (Isopoda: Valvifera: Arcturidae). *Zoosystematica Rossica* 3: 207–228.
- Kussakin, O.G., and Vasina, G.S. 1998. New bathyal and abyssal arcturids from the western Antarctic and Subantarctic (Crustacea: Isopoda: Arcturidae). *Zoosystematica Rossica* 7: 55–75.
- Nierstrasz, H.F. 1941. Die Isopoden der Siboga-Expedition. IV. Isopoda Genuina. III. Gnathiidea, Anthuridea, Valvifera, Asellota, Phreatoicoidea. *Siboga-Expedition* 19: 235–308.
- Nordenstam, A. 1933. Marine Isopoda of the families Serolidae, Idotheidae, Pseudidotheidae, Arcturidae, Parasellidae and Stenetriidae mainly from the South Atlantic. *Further Zoological Results of the Swedish Antarctic Expedition, 1901–1903* 3: 1–284, 282 pls, errata.
- Ohlin, A. 1901. Isopoda from Tierra del Fuego and Patagonia. I. Valvifera. *Wissenschaftliche Ergebnisse der Schwedischen Expedition in die Magellanregion oder nach den Magellansländern 1895–1897* 2: 261–306, pls 220–225.
- Paul, A.Z., and Menzies, R.J. 1971. Sub-tidal isopods of the Fosa de Cariaco, Venezuela, with descriptions of two new genera and twelve new species. *Boletín del Instituto Oceanográfico, Universidad de Oriente* 10: 29–48.
- Poore, G.C.B. 2001. Isopoda Valvifera: diagnoses and relationships of the families. *Journal of Crustacean Biology* 21: 205–230.

- Poore, G.C.B. 2003. Revision of Holidoteidae, an endemic southern African family of Crustacea, and re-appraisal of taxa previously included in its three genera (Isopoda: Valvifera). *Journal of Natural History* 37: 1805–1846.
- Poore, G.C.B. 2012. *Marmachius*, a spectacular new genus of Antarcticuridae (Crustacea: Isopoda: Valvifera). *Zootaxa* 3559: 61–68.
- Poore, G.C.B., and Bardsley, T.M. 1992. Austrarcturellidae (Crustacea: Isopoda: Valvifera), a new family from Australasia. *Invertebrate Taxonomy* 6: 843–908.
- Schotte, M., Boyko, C.B., Bruce, N.L., Poore, G.C.B., Taiti, S., and Wilson, G.D.F. 2008 onwards. World list of marine freshwater and terrestrial isopod crustaceans. <http://www.marinespecies.org/isopoda> accessed 1 March 2015.
- Schultz, G.A. 1978. Nonasellote isopod crustaceans from Anvers Island and other Antarctic locations. In: Pawson, D. L., and Kornicker, L. S. (eds), Biology of the Antarctic Seas 8. *Antarctic Research Series* 28: 21–41.
- Schultz, G.A. 1981. Arcturidae from the Antarctic and Southern Seas (Isopoda, Valvifera) Part I. In: Kornicker, L. S. (ed.), Biology of the Antarctic Seas 10. *Antarctic Research Series* 32: 63–94.
- Springthorpe, R., and Lowry, J. 1994. Catalogue of crustacean type specimens in the Australian Museum: Malacostraca. *Technical Reports of the Australian Museum* 11: 1–134.
- Stebbing, T.R.R. 1908. South African Crustacea, Part IV. *Annals of the South African Museum* 6: 1–96, pls 27–40.
- Wägele, J.W. 1987. The feeding mechanism of *Antarcturus* and a redescription of *A. spinacoronatus* Schultz, 1978 (Crustacea: Isopoda: Valvifera). *Philosophical Transactions of the Royal Society of London B* 316: 429–458.
- Wägele, J.W. 1989. Evolution und phylogenetisches System der Isopoda. Stand der Forschung und neue Erkenntnisse. *Zoologica (Stuttgart)* 140: 12–62.
- Wägele, J.W. 1991. *Antarctic Isopoda Valvifera*. Vol. 2. Koeltz Scientific Books: Königstein. 213 pp.
- Whitelegge, T. 1904. Scientific results of the trawling expedition of H.M.C.S. “Thetis” off the coast of New South Wales in February and March, 1898. Crustacea. Part IV. Isopoda. Part III. *Memoirs of the Australian Museum* 4: 405–416.
- zur Strassen, O. 1902. Über die Gattung *Arcturus* und die Arcturiden der Deutschen Tiefsee-Expedition. *Zoologischer Anzeiger* 25: 682–689.
- zur Strassen, O. 1903. Zusatz zu meinem Artikel über die Arcturiden. *Zoologischer Anzeiger* 26: 31.

Five athecate hydroids (hydrozoa: anthoathecata) from south-eastern australia

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Abstract

Watson, J.E. 2015. Five athecate hydroids (hydrozoa: anthoathecata) from south-eastern australia. *Memoirs of Museum Victoria* 73: 19–26.

Hydractinia gelinea sp. nov. is described and *Amphinema dinema* recorded for the first time from south-eastern Australia. Three previously known species, *Eudendrium pennycuikae*, *Ectopleura exxonia* and *Pennaria wilsoni* are redescribed in detail.

Keywords

Athecate hydroids, south-eastern Australia, new species, new record, redescription of species.

Introduction

This report describes a collection of five hydroid species from south-eastern Australia. A new species, *Hydractinia gelinea* is described. There is a new but somewhat doubtful record of *Amphinema dinema*. The range of *Eudendrium pennycuikae* is extended from subtropical Queensland to cool temperate southern Australia. *Pennaria wilsoni* and *Ectopleura exxonia* are redescribed in detail, the latter being recorded for the first time from New Zealand.

Type and voucher material is lodged in Museum Victoria (NMV).

Hydractiniidae L. Agassiz, 1862

Hydractinia van Beneden, 1841

Hydroid colony either stolonal with a reticular hydrorhiza of perisarc-covered stolonal tubes or covered by encrusting mat; hydrorhizal mat may secrete chitinous or calcareous skeleton or spines, pillars or branches. Polyps sessile, polymorphic, naked, gastrozooids with one or more whorls of oral filiform tentacles or with scattered tentacles on the distal half of body, dactylozooids when present with or without tentacles. Reproduction by sessile sporosacs or free medusa, gonophores typically borne on gonozooids; gonozooids with one or more whorls of oral tentacles or without tentacles and mouth, giving rise to fixed sporosacs, eumedusoids or free medusa.

Hydractinia gelinea sp. nov.

Figure 1A–D

Material examined. NMV F202870, holotype, female colony, Crawfish Rock, Western Port, Victoria, coll: J. Watson, 24/04/2006, depth 10 m; material fixed in 5% formalin, later transferred to 70% ethanol.

Description. Colony comprising individuals and clusters of female polyps on a dead crustose bryozoan; no gastrozooids or dactylozooids present. Hydrorhiza ramified, firmly adherent to substrate, stolons narrow, tubular, perisarc thin and smooth.

Gonozooids sessile, robust, with a whorl of 8–12 thick tentacles surrounding a prominent dome-shaped hypostome; tentacles with prominent whorls of nematocysts. Hypostome high dome-shaped. Gonophores fixed sporosacs borne in tight clusters of up to 15 on gonozooid well below tentacles. Immature female gonophore pyriform, containing many small ova, mature gonophore balloon-shaped to spherical, seated on a cushion-shaped pad on a short peduncle and enclosed in a thick gelatinous pellicle, surface of gonophore with abundant large scattered nematocysts.

Nematocysts, probably euryteles of two sizes; none discharged:

- (i) capsule bun-shaped, 18–21 x 9–10 μm , on gonophores and body of gonozooid,
- (ii) capsule ovoid, 9–12 x 6–7 μm , on gonozooid tentacles.

Colour (recently preserved material): stolons yellow, gonozooids and gonophores flesh pink.

Table 1. Measurements (μm) of *Hydractinia gelinea* (preserved material)

Hydrorhiza, width	48–72
Hydranth	
maximum length, base to tip of tentacles	1400
width of body	280–320
Sporosac, mature, maximum width	250–400

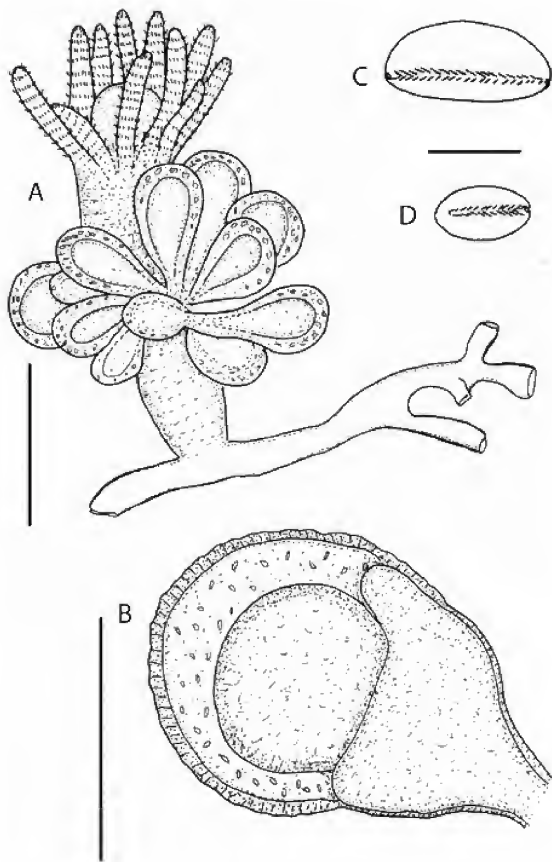


Figure 1A-D. *Hydractinia gelinea* sp. nov. Holotype (NMV F202870). A, hydranth with developing gonophores; B, mature gonophore with scattered nematocysts; C, undischarged heteroneme from hydranth body and gonophores; D, undischarged heteroneme from tentacles. Drawn from preserved material. Scale bar: A, 0.5 mm; B, 0.2 mm; C, D, 10 μ m.

Remarks. The colony is clustered in the pores of a dead bryozoan *Celleporaria* sp., some polyps encroaching onto a small sponge growing on the bryozoan. No encrusting hydrorhizal mat or dactylozooids were found. The thick ectoderm enclosing the gonophore obscures the position of the spadix, masking its structural details. The immature female gonophore contains numerous small ova c. 40 μ m in diameter.

There are about 130 nominal species of Hydractiniidae, mostly recorded from the northern hemisphere, although many are inadequately described (Miglietta *et al.* 2009). The only presently known *Hydractinia* from south-eastern Australia is *H. betkensis* (Watson 1978).

Choice of substrate is important in the Hydractiniidae, encrusting colonies often being associated with mobile substrata while reticulate colonies (such as *H. gelinea*) are usually associated with immobile substrata (Miglietta and Cunningham 2012). Other known associations are with

pebbles, barnacles, sponges and other hydroids (Schuchert 2008) but there are no records of association with bryozoans.

As the nematocysts were not discharged their exact identity could not be determined, but they are probably euryteles; no desmonemes were seen. Euryteles and desmonemes are known to comprise the cnidome of *Hydractinia* and these were recorded in *Hydractinia novaezealandiae* (Schuchert, 1996) and *Hydractinia rubricata* (Schuchert, 1996) from New Zealand.

Etymology. named for the cushion-like gelatinous pellicle supporting the sporosac.

Family **Pandaeidae** Haeckel, 1879

Amphinema Haeckel, 1879

Diagnosis. Colonies stolonial, hydrorhiza creeping, hydrocaulus well developed, unbranched, covered by perisarc, longer than extended hydranth; hydranths spindle-shaped with one whorl of amphicoronate filiform oral tentacles, with conical hypostome. Gonophores arising either on stolon or caulus or both, releasing free medusae. Medusa generally with a large apical projection, with two opposite tentacles, without gastric peduncle, with marginal warts, manubrium with broad base and four simple lips, gonads on manubrium in adradial or interradial position, ocelli and marginal cirri may be present.

Amphinema dinema (Péron and Lesueur, 1810)

Figure 2A–G

Oceania dinema Péron and Lesueur, 1810: 346.

Perigonimus serpens Allman, 1863: 10.

Stomatoca dinema. – Mayer, 1910: 109, pl. 9, figs 8–10, pl. 10, figs 1–4.

Amphinema dinema. – Rees and Russell, 1937: 62, figs 1–4. – Russell, 1953: 180, pl. 10, figs 1, 2, 4, pl. 11, figs 1, 3, text-fig. 89. – Kramp, 1959: 117, fig. 109. – Kramp, 1961: 93. – Kramp, 1968: 42, fig. 108. – Goy *et al.* 1991: 109, fig. 24. – Schuchert, 1996: 63, fig. 36.

Material examined. NMV F202871, Clifton Springs jetty ruins, Port Phillip, fertile colony on mussel *Mytilus galloprovincialis*, depth 0.2 m, coll: J. Watson, 10/12/2008. Material fixed in 5% formalin later preserved in 70% ethanol.

Description (from live material). Colony stolonial, hydrorhiza reptant on substrate, stolons tubular, faintly rugose to smooth, perisarc relatively thick. Hydrothecal pedicels scattered along hydrorhiza, hydrocaulus erect, cylindrical, unbranched, of same diameter at base as hydrorhiza, diameter increasing distally, perisarc thin with several obscure corrugations above base, continuing upwards for variable distance, corrugations gradually becoming indistinct then fading out. Hydranth long spindle-shaped, extending well above hydrotheca, hypostome high-domed, quadrate when viewed from above, with 8–10 long tentacles in a single indefinite whorl held out stiffly below hypostome.

Medusa buds globular, arising on short, corrugated pedicels along hydrorhiza. Prior to release one tentacle emerges, followed by a second tentacle one to two hours later. At release, medusa deep bell-shaped to hemispherical with two opposite tentacles on large tapering bulbs,

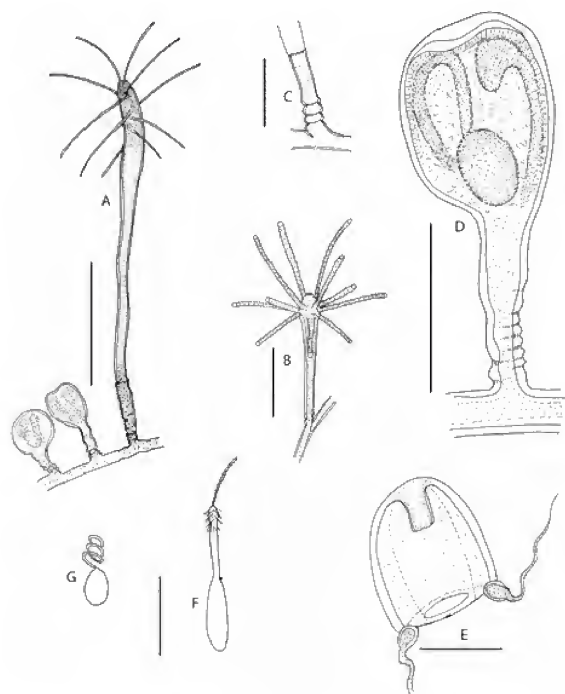


Figure 2A-G. *Amphinema dinema*. A, hydrocaulus with extended hydranth and gonophores on hydrorhiza. B, contracted hydranth, C, corrugated hydrocaulus. D, nearly mature gonophore. E, newly released medusa, F, eurytele from tentacles, G, desmoneme from hypostome. Scale bar: A, B, E, 0.5 mm, C, 0.3 mm, D, 0.2 mm, F, G, 10 μ m.

manubrium cylindrical in lateral view, quadrate in dorsal, umbrella without apical projection, small nematocysts sparsely scattered over bell, velum a broad shelf, radial canals thin, a small wart at base of each canal. After four days in the laboratory, medusa remained of same shape and size as at release; no apical projection, manubrium with four indistinct lips, a small marginal wart between radial canals. After five days, manubrium extending almost halfway down bell.

Cnidome comprising two categories of nematocysts:

- (i) microbasic euryteles, capsule narrowly elongate, 7–10 x 2.5–3.5 μ m (discharged), shaft thin, 7–10 μ m, thread very long; abundant in tentacles of hydranth and medusa and scattered over bell of medusa; easily discharged.
- (ii) desmonemes, almond shaped, 4–6 x 2.5–3.5 μ m (undischarged) on hydranth.

Hydrorhiza pale brown, hydrocaulus, body of hydranth and tentacles translucent white, stomach region below tentacles orange. Umbrella of medusa and radial canals colourless, tentacle bulbs and manubrium orange-brown; colour fading after five days.

Table 2. Measurements (μ m) of *Amphinema dinema* (live material)

Hydrorhiza width	44–80
Hydrotheca	
width at base	44–72
length	250–400
Hydranth	
length, fully extended	500–1200
length of extended tentacle	300–500
Medusa	
length of bud	30–35
height, 4 days old	70

Remarks. The hydrothecae vary considerably in length within and amongst the colonies, shorter hydrothecae having a slightly thicker and more visible perisarc while longer ones usually have a thinner, sometimes almost invisible perisarc. The perisarc is often lightly coated with fine sediment. The hydranth is very active, bending from side to side when disturbed; one was observed capturing and ingesting a small amphipod. When the hydranth is extended the tentacles are scattered over the distal body region but when contracted they appear as an indefinite whorl.

The tentacles of the medusa are remarkably long, about 20 times the length of the bell. The medusa is very active, swimming with rapid jerking movements.

Medusae of *Amphinema dinema* were originally reported from the English Channel and later from the plankton of north-eastern Australia (Kramp 1968). It was found in New Zealand (Schuchert 1996) so it was only a matter of time before also being recorded from southern Australia.

The present material agrees in most respects with Schuchert's (1996) description of the hydroid and early medusa stages of the New Zealand species but differs in: i) the manubrium of the newly released medusa is only one third the height of the bell, ii) the manubrium is yellow, not red as in the New Zealand material, iii) there was no indication of development of an apical projection in medusae up to five days old. While the apical projection is considered an important diagnostic character, in the present case it may have been due to retardation of growth in the laboratory. Despite these differences and until further material is available for study I refer the species to *Amphinema dinema*.

Distribution. North-eastern Australia, India, Mediterranean Sea, north-western Europe, east coast of North America, New Zealand. This is the first record of *Amphinema dinema* from southern Australia.

Family **Eudendriidae** L. Agassiz, 1862

Eudendrium Ehrenberg, 1834

Diagnosis. Colony with erect, usually branched stems arising from a creeping hydrorhiza. Hydrocaulus enclosed in a firm perisarc extending to hydranth base; hydranth large with a pedunculated hypostome and one whorl of filiform tentacles; gonophores fixed sporosacs borne on hydranth body below tentacles, male gonophores usually with several chambers, female with a single egg.

Eudendrium pennycuikae Watson, 1985

Figure 3A–F

Eudendrium album Pennycuik, 1959: 167.

Eudendrium pennycuikae Watson, 1985: 183, figs 5–8.

Material examined. NMV F202872, jetty pontoon at Clifton Springs, Port Phillip, on ascidian *Molgula ficus*, depth 0.3 m, coll: J.Watson, 18/12/2013. Material examined alive, fixed in 4% formalin then transferred to 70% ethanol.

Description (from live material). Hydrorhizal stolons loosely reptant on ascidian. Hydrocaulus monosiphonic, of same diameter as stolon, to 16 mm high, sparsely and irregularly branched without definable main stem. Lowest branch with up to 15 wide annulations, upper branches with up to 10 proximal annulations at branch junction, younger branches smooth, older branches obscurely annulated or wrinkled but always smooth distally below hydranth.

Hydranth large, erect, terminal on branch, body constricted at base then becoming almost cylindrical, hypostome distinctly pedunculate, surrounded by 16–20 long tapering semi-amphicoronate tentacles. No nematocyst rings or pads.

Developing female gonophore encircled by a moderately thick unbranched spadix, gonophores at various stages of maturity scattered singly or in clusters of two to five on blastostyle. Spadix lost at maturity, hydranth tentacles shortening and becoming resorbed, mature gonophores with approximately 20 ova attached to blastostyle on short peduncles. Male gonophores comprising two to four (usually three) linear bead-like chambers in clusters of up to 12 on a blastostyle without hydranth, distal chamber flat bun-shaped with scattered nematocysts; no apical nematocyst pad.

Cnidome comprising microbasic euryteles of one size, capsule elongate elliptical, 11–12 × 5–5.5 µm (undischarged), 8–9 × 4 µm (when discharged), shaft 4–6 µm long with a few spines, thread long; in tentacles and coenosarc.

Stolons and older stems pale honey brown, younger stems paler, hydranth body flesh pink, tentacles transparent, male gonophores almost white, spadix pale brown, female gonophores pale yellow.

Remarks. This is the first description of *Eudendrium pennycuikae* from live material, the original description of Pennycuik (1959) and Watson's later redescription (1985) being from preserved material held by the Queensland Museum. The present record extends the range of *E.*

Table 3. Measurements (µm) of *Eudendrium pennycuikae* (live material)

Hydrorhiza, stolon and branch width	100–150
Hydranth	
width across extended tentacles	1000–1800
length of tentacles	400–500
length of body including hypostome	420–680
hypostome height	~100
maximum diameter of body	150–300
Gonophore	
mature female, diameter	200–260
mature male, length of linear cluster	500–600
mature male diameter distal chamber	200–230

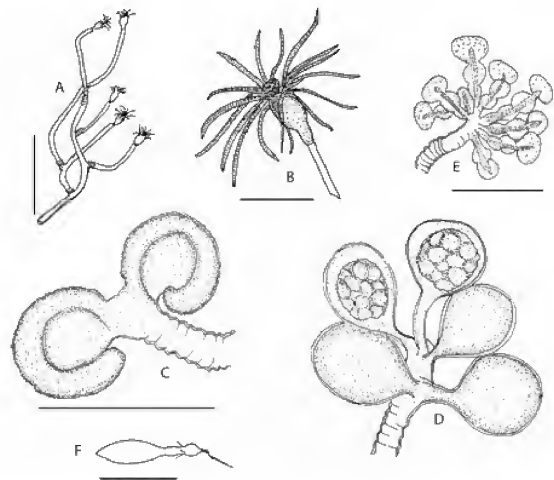


Figure 3A–G. *Eudendrium pennycuikae*. A, branch with hydranths; B, hydranth with extended tapering tentacles; C, developing female gonophores; D, mature female gonophores; E, cluster of male gonophores; F, eurytele from tentacles. Drawn from preserved material. Scale bar: A, 2 mm, B, 0.3 mm, C, D, E, 0.5 mm, F, 10 µm.

pennycuikae from subtropical Queensland to cool temperate southern Australia.

The large elegant pink hydranths with a whorl of long semi-amphicoronate tentacles is a conspicuous character in live material, differing markedly from the small hydranths with a whorl of blunt tentacles typical of southern species of *Eudendrium*.

The capsule of the eurytele was found to shrink 15–20% during discharge; while capsules usually shrink about 10% at discharge (author's obsv.) such a large reduction in size is unusual.

Family **Tubulariidae** Fleming, 1828*Ectopleura* L. Agassiz, 1862

Diagnosis. Hydroid solitary or colonial, hydrocaulus simple, with open lumen, without parenchymatic endoderm or longitudinal canals but weakly divided by two rarely up to five internal longitudinal endodermic ridges, perisarc thin, a collar on neck region that does not cover whole neck; hydranth vasiform with one whorl of filiform oral tentacles and a whorl of long, filiform aboral tentacles; gonophores borne above aboral tentacles producing either free medusae, eumedusoids or fixed sporosacs.

Ectopleura exxonia (Watson, 1978)

Figure 4A–H

Ectopleura exxonia Watson, 1978: 303, figs 1A, B.

Material examined. NMV F202873, Crib Point petroleum wharf, Western Port, Victoria, coll: J. Watson, 23/04/2006, depth 2 m; abundant fertile colonies on mussel (*Mytilus galloprovincialis*) shells. Hardened in 4% formalin later transferred to 70% ethanol. NMV F203425, from ropes at salmon farm, depth 5 m, Tory Channel, Marlborough Sounds, South Island, New Zealand, coll: J. Atalah, Cawthron Institute, Nelson, New Zealand.

Description (from preserved material, Western Port). Colonies growing thickly on mussel shells, hydrorhiza of matted closely ramified stolons. Stems crowded, to 80 mm long, unbranched but often entangled, several basal annulations on hydrocaulus and groups at intervals along stem, some stems completely annulated; perisarc smooth, firm. Hydrocaulus circular in section, with two internal longitudinal canals, one central inside the other. Distal end of hydrocaulus a shoulder surmounted by a short cylindrical section with thinner perisarc, a narrow circular indentation below hydranth, base of hydranth saucer-shaped. Hydranth with a single whorl of 12–15 short, thick oral tentacles surrounding a large hypostome and one whorl of 16–18 long, slender aboral tentacles.

Gonophores fixed sporosacs in various stages of development borne in tight clusters on short unbranched blastostyles at base of aboral tentacles. Gonophore spherical at maturity with a bun-shaped distal cap with emerging larval tentacles.

Cnidome comprising nematocysts in two categories:

- (i) stenoteles, capsule spherical, diameter 11–13 μm , shaft wide; on hypostome and oral tentacles, a few on aboral tentacles; some discharged.
- (ii) stenoteles, capsule spherical, diameter 5–7 μm , shaft wide; abundant on aboral tentacles, some on oral tentacles; a few discharged.
- (iii) heteronemes, capsule 10–11 x 5–7 μm , abundant in tentacles and cauline coenosarc; undischarged.

Hydranths and gonophores rose pink, stems shining white, tentacles white.

Remarks. The holotype (NMV G2801) of *Ectopleura exxonia* (Watson, 1978) was a small sample collected from an oil production platform at a depth of 75 m in Bass Strait. The present abundant material permits additional description.

Table 4. Measurements (μm) of *Ectopleura exxonia* (preserved material)

Hydrorhizal stolon, diameter	260
Stem, diameter	220–540
Hydranth	
diameter at base	280–450
length of oral tentacles	360–400
length of aboral tentacles	1900–2000
Gonophore, diameter	320–400

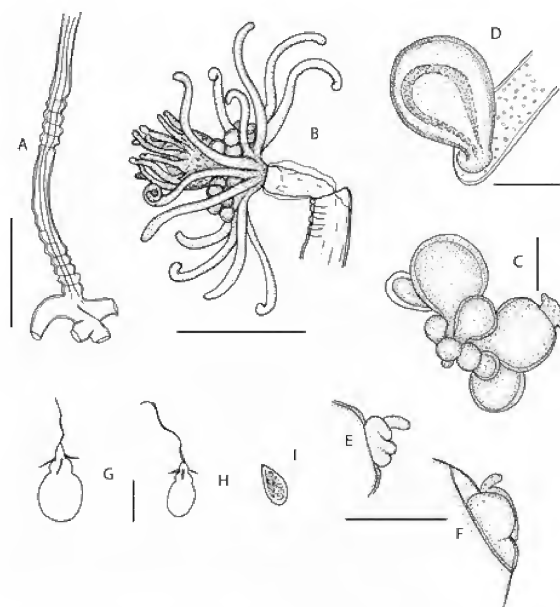


Figure 4A–I. *Ectopleura exxonia*. A, proximal stem and hydrorhiza; B, hydranth with immature gonophores (after Watson, 1978); C, cluster of developing gonophores; D, developing gonophore at base of aboral tentacle; E, F, apical process on nearly mature gonophore; G, stenotele from aboral tentacle; H, stenotele from oral tentacle; I, heteroneme from tentacles. Scale bar: A, B, 1 mm, C, 0.2 mm, D, 0.3 mm, G–I, 10 μm .

The hydrocaulus of *E. exxonia* was originally described as having four longitudinal internal canals. Examination of the present material shows however, there are only two canals – an outer perisarc-covered caulus and a single internal cylindrical canal passing up the centre of the stem.

The somewhat smaller size of the hydranths and gonophores of the Crib Point material than in the holotype may be due to the Crib Point colonies being less than eight weeks old, dating from the time of deployment of clean mussel substrate to the time of retrieval. Water temperature at deployment was 20°C declining over the immersion period to 15°C.

Schuchert (1996) predicted that *E. exxon* would occur in New Zealand. Recent sampling at a salmon farm at a depth of 5 m in Tory Channel, Marlborough Sounds, South Island, New Zealand has confirmed his prediction, revealing well established colonies of *E. exxon* growing on farm nets.

Family **Pennariidae** McCrady, 1859

Diagnosis. (modified after Calder 2010). Capitae hydroids with erect colonies; stems monosiphonic, branches giving rise to hydranth pedicels, perisarc firm. Hydranth naked, spindle-shaped, with an aboral whorl of long filiform tentacles semicapitate distally, an oral whorl of short, capitate tentacles. Eumedusa without manubrium, with four radial canals and four rudimentary tentacles bulbs, velum not penetrated.

Pennaria wilsoni (Bale, 1913)

Figures 5, 6A–J

Pennaria wilsoni Bale, 1913: 116.– Blackburn, 1937: 176, figs 8, 9.– Hirohito, 1988: 30, fig. 9e.

Halocordyle australis Bale, 1894: 94.– Pennycuik, 1959: 160, pl. 1, fig. 8.– Watson 1982: 88, fig. 4.6 g, h, pl. 10.2.

(?)*Pennaria wilsoni* Gibbons and Ryland, 1989: 388, fig. 6.– Kirkendale and Calder, 2003: 166.– Bouillon *et al.* 2006: 247.– Calder, 2010: 65.

Material examined. NMV F202880, Popes Eye reef, southern Port Phillip, on rubble, depth 8 m, coll: J. Watson, 26/08/2013. Material examined alive, later fixed in 4% formalin, then transferred to 70% ethanol.

Description (from live material). Mature colonies comprising one to many branched stems to 20 cm long arising from a ramified hydrorhiza, stolons tubular, almost smooth in young colonies to rugose and gnarled in older colonies.

Stems erect, monosiphonic, flexuous, cylindrical, perisarc smooth and shining, straight to weakly sympodial, a slight change of direction at origin of each primary branch; branches widely separated along stem in indefinite whorls of three, directed upwards at 30–40° to stem. Stem widest at base, narrowing slightly distally, ringed above base with up to 50 deep annulations and with up to 20 deep annulations above origin of older branches; sometimes groups of annulations along stem not associated with branching.

Hydranth pedicels variable in length (depending on age of colony), widely separated, given off more or less triserially, up to 15 on weakly annulated pedicels, sometimes with a smooth mid-section, branch always with a terminal hydranth. Hydranth long, cylindrical to spindle-shaped, hypostome flattened dome-shaped. Four to five, rarely six short capitate oral tentacles clustered around hypostome, tentacles transversely segmented, each segment with a small central reddish spot, capitula with batteries of nematocysts. Aboral tentacles long, slender, semicapitate, in one whorl of 7–8, arched in life, a thick fringe of nematocysts along the outer side of tentacle, inner side transversely segmented with large transparent cells with reddish inclusions.

Table 5. Measurements (μm) of *Pennaria wilsoni* (live material)

Hydrorhiza, diameter	200–400
Stem	
width at base	200–500
distance between primary branches	375–570
width primary branch	200–500
Pedicel	
distance between pedicels	1000–3500
length	200–300
width	70–120
Hydranth	
body length extended	500–700
length of extended aboral tentacle	2000–3000
length oral (capitate) tentacle	250–350
Eumedusa at release	
length	1050
width at base of bell	1000

Gonophore eumedusoid, ovoid to oblong, one to four in various stages of development on short peduncles just above aboral tentacles. At release umbrella thick, evenly covered in nematocysts, radial canals straight, gonads large, brown, tentacles reduced to knobs, velum closed, female with large ova. Medusa pulsates feebly before and after release.

Perisarc of stem and branches thick, shining brown, hydranth pedicels paler brown; hydranth and tentacles translucent white, stomach brown to red. Medusa colourless, manubrium red, radial canals reddish before release, becoming brown after release.

Cnidome comprising four categories of nematocysts; stenoteles present in a wide range of shapes, sizes and abundances, even between hydranths on the same stem.

- (i) stenoteles, capsule large, elongate ovoid, 51–56 x 27–31 μm , shaft 50 μm long, cylindrical, head 15 μm long with 2–4 long basal spines, distal part of head with many small bristles, spinous thread at least 30 μm long, in capitate tentacles and at base of medusa; easily discharged.
- (ii) stenoteles, similar to but smaller than stenotele (i), capsule elongate ovoid 44–45 x 20–22 μm , shaft cylindrical, 40 μm long, base of head with 2–4 long spines, head distally with bristles, thread with many small spines; in capitate tentacles, easily discharged.
- (iii) stenoteles, capsule ovoid, 19–20 x 14 μm , shaft stout, 19 μm long, head with several spines; in oral tentacles; easily discharged.
- (iv) stenoteles, capsule ovoid, 11–13 x 8–10 μm , shaft 10 μm long, abundant in aboral tentacles; difficult to discharge.
- (v) stenoteles, capsule inflated ovoid, 25 x 23 μm , in aboral tentacles; undischarged.

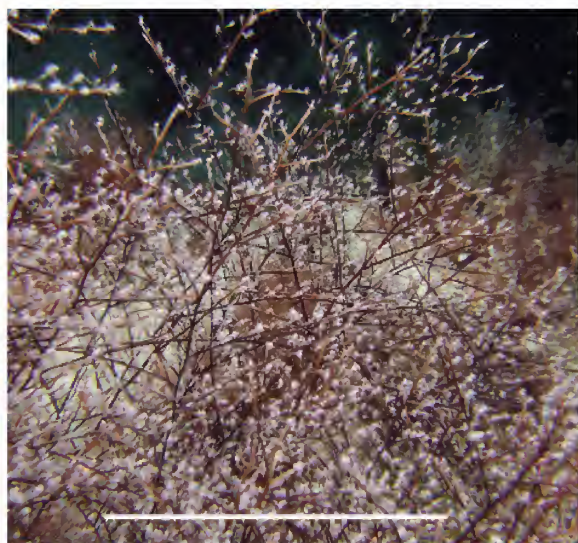


Figure 5. *Pennaria wilsoni*. In situ photograph of colony, Port Phillip Heads, depth 10 m, showing bushy growth habit (photograph by author). Scale bar: 5 cm.

- (vi) isorhizas, capsule loaf-shaped $15 \times 5\text{--}7 \mu\text{m}$, thread long, abundant in aboral tentacles; difficult to discharge.
- (vii) microbasic mastigophores, capsule elongate pyriform, $15\text{--}19 \times 6 \mu\text{m}$, shaft $12 \mu\text{m}$, spinous, thread coiled in a circle at base of capsule, abundant in aboral tentacles and on medusa; difficult to discharge.
- (viii) desmonemes, capsule almond shaped, $7 \times 4.5\text{--}5 \mu\text{m}$, rare in aboral tentacles and around hypostome; undischarged.

Remarks. *Pennaria* is a genus with five accepted species (Bouillon *et al.* 2006, Schuchert 2006). *Pennaria disticha* is the best known of the group with cosmopolitan distribution in tropical and temperate seas; it is present around Australia except in cooler Victorian waters (author's *pers. obsv.*).

P. disticha. Bale (1894) described *Halocordyle australis* from Capel Sound, Port Phillip. The hand written label on the presumed holotype microslide (NMV F58747) is not Bale's and may be that of the collector, John Bracebridge Wilson. Ralph (1966) reported *Pennaria disticha* from a benthic material from southern Port Phillip collected by the National Museum of Victoria Port Phillip (1957). Examination of this material (NMV F150168, F150169) shows it to be *Pennaria wilsoni*, not *Pennaria disticha*. The flexuous spirally branching habit of *P. wilsoni* easily distinguishes it from the pinnate stems of *P. disticha*. Bale (1913) renamed the species *Pennaria wilsoni* and Blackburn (1937) described and figured the gonophores of material from Western Port, Victoria.

Gibbons and Ryland (1989) reported fertile material as *Pennaria wilsoni* from Suva Barrier Reef, Fiji and Kirkendale

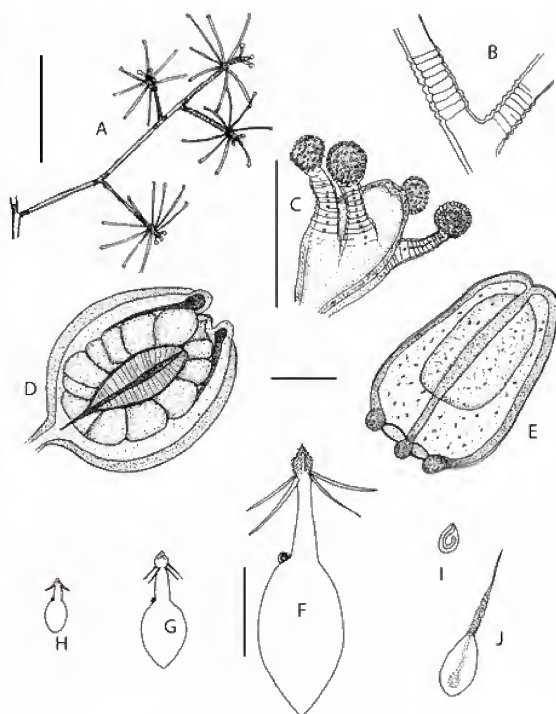


Figure 6A-J. *Pennaria wilsoni*. A, branch with extended hydranths; B, basal annulations of branch; C, capitulate tentacles surrounding hypostome; D, developing female gonophore; E newly released released eumedusa with scattered nematocysts; F-H, stenoteles from oral and aboral tentacles; I, desmoneme from hypostome; J, microbasic mastigophore from aboral tentacles. Scale bar: A, 5 mm, B, D, E, 0.5 mm, C, 0.25 mm, F-J, 20 μm .

and Calder (2003) also referred infertile tropical material from Guam to *P. wilsoni*. Gibbons and Ryland's microslide mount (GL 10177) loaned by the Queensland Museum contains several mature balloon-shaped gonophores approximately 1.5 mm long and 1.2 mm wide, but the contents are too degraded for description. I have examined four preserved samples of infertile material from the Pennycuik collection (QM 5513-5516 inclusive) loaned by the Queensland Museum. The material was collected from under coral reef shelves, 21-24th August, 1954, at a depth of 2 m at the Low Isles on the Great Barrier Reef, Queensland. The Fiji and Great Barrier Reef material are clearly the same species.

The only sure means of determining whether there are two or one geographically wide-ranging species is based on morphology of the cnidome. For comparison with *P. wilsoni* a small crushed hydranth of QM 5515 was examined under high magnification. The scarcely distinguishable nematocysts in the capitulate tentacles comprised some undischarged ?stenoteles of three sizes: i) $28\text{--}36 \times 20\text{--}24 \mu\text{m}$, ii) $25 \times 17 \mu\text{m}$ and iii) $11\text{--}12 \times 8\text{--}9 \mu\text{m}$. While allowing for approximately 10% shrinkage in preservation, the largest capsules are much

smaller than those of fresh *P. wilsoni*. Therefore, until the cnidome and gonophores of fresh tropical material are available for examination it the tropical material is best regarded as a different species.

The extensive and highly variable cnidome with nematocysts of four categories is similar to that described for *Pennaria disticha* (see Schuchert 1996), but in *P. wilsoni* the largest stenoteles are bigger than those of *P. disticha*. In *P. wilsoni* the relative abundance of the larger sizes of stenoteles varies between hydranths, sometimes from the same stem. The smaller stenoteles, microbasic mastigophores and isorhizas are present in all hydranths while desmonemes are sometimes rare. Uneven distribution of the large stenoteles may be related to maturity of the hydranth, the larger ones usually occurring on the older hydranths.

Pennaria wilsoni is known from several Victorian localities and is likely to be more widespread than is presently known. Colonies are most luxuriant in strong current flow on open reef at 6–10 m depth while in less rigorous environments they usually comprise only a few stems. Colonies persist throughout the year with major growth during winter months at water temperatures of 10–14°C, becoming moribund over summer. Mature colonies are host to many epizoots including other small hydroids, anemones and ascidians; as the water temperature increases in late winter they are often overgrown by small filamentous red algae. Hydranths and gonophores are heavily preyed upon by the pycnogonid *Tanystylum* and several species of the nudibranch *Trinchesia*.

Acknowledgements.

My thanks to David Staples for his expertise on associations between pycnogonids and hydroids, to Robert Burn for advice on nudibranchs and to Javier Atalah of the Cawthron Institute, New Zealand for provision of samples. Thanks also to reviewers for their comments which greatly improved the manuscript.

References

- Agassiz, L. 1862. *Contributions to the Natural History of the United States of America*. Volume 4, Little, Brown and Co., Boston. 380 pp.
- Allman, G. J. 1863. Notes on the Hydroida. *Annals and Magazine of Natural History* 11(3): 1–12.
- Bale, W.M. 1894. Further notes on Australian hydroids, with descriptions of some new species. *Proceedings of the Royal Society of Victoria*, new series 6: 93–117.
- Blackburn, M. 1937. Notes on Australian Hydrozoa, with descriptions of two new species. *Proceedings of the Royal Society of Victoria* 50: 170–181.
- Bouillon, J., Gravili, C., Pagès, F., Gili, J.-M., and Boero F. 2006. An introduction to Hydrozoa. *Mémoires du Muséum national d'Histoire naturelle* 194: 1–591.
- Calder, D.R. 2010. Some anthoathecate hydroids and limnopolyps (Cnidaria, Hydrozoa) from the Hawaiian archipelago. *Zootaxa* 2590: 1–91.
- Ehrenberg, C.G. 1834. Beiträge zur physiologischen Kenntniss der Corallenthiere im allgemeinen und besonders des Rothen Meeres, nebst einem Versuche zur physiologischen Systematik derselben. *Physicalische Matematische Abhandlungen der Königlichen Akademie der Wissenschaften zu Berlin*: 225–380.
- Gibbons, M.J., and Ryland, J.S. 1989. Intertidal and shallow water hydroids from Fiji. Athecata to Sertulariidae. *Memoirs of the Queensland Museum* 27(2): 377–432.
- Goy, J., Lakkis, S., and Zeidane, R. 1991. Les méduses (Cnidaria) des eaux Libanaises. *Annales de l'Institut Océanographique Paris* 67: 90–128.
- Haeckel, E. 1879. *Das System der Medusen*. 2 vols. Gustav Fischer Verlag, Jena. (reprinted 1986, VEB Gustav Fischer, Jena).
- Hirohito, Showa Emperor of Japan, 1988. The hydroids of Sagami Bay (Part 1. Athecata). *Publications of the Biological Laboratory of the Imperial Household, Tokyo* 1–79.
- Kirkendale, L., and Calder, D.R. 2003. Hydroids (Cnidaria: Hydrozoa) from Guam and the Commonwealth of the Northern Marianas Islands (CNMI). *Micronesia* 35–36: 159–188.
- Kramp, P.L. 1959. The Hydromedusae of the Atlantic Ocean and adjacent waters. *Dana Reports* 46: 1–283.
- Kramp, P.L. 1961. Synopsis of the medusa of the world. *Journal of the Marine Biological Association of the United Kingdom* 40: 1–469.
- Kramp, P.L. 1968. The Hydromedusae of the Pacific and Indian Oceans sections II and III. *Dana Reports* 72: 1–200.
- Miglietta P.M., and Cunningham C.W. 2012. Evolution, life cycle, colony morphology, and host specificity in the family hydractiniidae (Hydrozoa, Cnidaria). *Evolution* 66-12: 3876–3901.
- Miglietta P.M., Schuchert, P., and Cunningham C.W. 2009. Reconciling genealogical and morphological species in a worldwide study of the family hydractiniidae (cnidaria, hydrozoa). *Zoologica Scripta* 38: 403–430.
- Pennycuik, P.R. 1959. Faunistic records from Queensland. Part V. Marine and brackish water hydroids. *Papers of the Department of Zoology, University of Queensland* 1: 141–210.
- Péron F., and Lesueur, C.A. 1810. Histoire general et particulière de tous les animaux qui component le famille des méduses; tableaux des caractères génériques et spécifiques de toutes les espèces de méduses connues jusqu'à ce jour. *Annales du Muséum National d'Histoire Naturelle, Paris XIV*: 312–366.
- Rees, W.J., and Russell, F.S. 1937. On rearing the hydroids of certain medusae, with an account of the methods used. *Journal of the Marine Biological Association of the United Kingdom* 22: 61–81.
- Russell, F.S. 1953. *The Medusae of the British Isles. Anthomedusae, Leptomedusae, Limnomedusae, Trachymedusae and Narcomedusae*. Cambridge University Press, Cambridge: 530 pp.
- Schuchert, P. 1996. The Marine Fauna of New Zealand: Athecate hydroids and their medusae (Cnidaria: Hydrozoa). *New Zealand Oceanographic Institute Memoir* 106: 1–159.
- Schuchert, P. 2006. The European athecate hydroids and their medusae (Hydrozoa, Cnidaria). *Review suisse de Zoologie* 113: 325–410.
- Schuchert, P. 2008. The European athecate hydroids and their medusae (Hydrozoa, Cnidaria). *Review suisse de Zoologie* 115: 221–302.
- Watson, J.E. 1978. New species and new records of Australian athecate hydroids. *Proceedings of the Royal Society of Victoria* 90: 301–414.
- Watson, J.E. 1982. Hydroids (Class Hydrozoa). Pp. 79–115 in: Shepherd S.A., and Thomas, I.M. (eds), *Marine Invertebrates of Southern Australia*. Part I. Handbook of the Flora and Fauna of South Australia. Handbooks Committee, South Australian Government, Adelaide.
- Watson, J.E. 1985. The genus *Eudendrium* (Hydrozoa: Hydroida) from Australia. *Proceedings of the Royal Society of Victoria* 97(4): 179–221.

New asterinid seastars from northwest Australia, with a revised key to *Aquilonastra* species (Echinodermata: Asteroidea)

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Abstract

O'Loughlin, P.M. and Bribiesca-Contreras, G. 2015. New asterinid seastars from northwest Australia, with a revised key to *Aquilonastra* species (Echinodermata: Asteroidea). *Memoirs of Museum Victoria* 73: 27–40.

The Woodside/Western Australian Museum Kimberley Project 2008–2015 collected four small asterinid seastar specimens from Cassini Island and Long Reef in the Kimberley region of north Western Australia. The specimens are lodged in the Western Australian Museum. They represent two new species of *Aquilonastra* O'Loughlin: *Aquilonastra alisonae* sp. nov.; *Aquilonastra cassini* sp. nov. An updated key is provided for species assigned to *Aquilonastra*, and a table distinguishing *Aquilonastra* species from the Kimberley region.

Keywords

Kimberley; Woodside/Western Australian Museum Kimberley Project 2008–2015; *Aquilonastra*; new species; fissiparous.

Introduction

The goal of the Woodside/Western Australian Museum Kimberley Project is to generate a comprehensive understanding of the marine biodiversity of the Kimberley region of north Western Australia. Sampey *et al.* (2014) published on the history, aims, scope and methodology of this project. The WA Museum and Woodside Energy Ltd. undertook a partnership in 2008 for a six-year program to document selected marine biota of the Kimberley region. A recent publication on the echinoderms by Sampey & Marsh (2015) provides information on the historical echinoderm collections from the region.

O'Loughlin & Waters (2004) revised all of the genera of family Asterinidae. Four new genera were created, and all genera diagnosed. A key to the genera was provided. New morphological characters were defined and illustrated. Amongst the new genera was *Aquilonastra* O'Loughlin (in O'Loughlin & Waters 2004). A table of all asterinid species was provided, with original and current combinations. O'Loughlin & Waters concluded that Asterinidae is a cosmopolitan family, mainly of shallow-water narrow-distribution-range genera but including some more widespread genera in deeper waters of all oceans. O'Loughlin & Rowe (2005) described an additional asterinid genus, *Ailsastra*, from the Indo-West Pacific region. Six species were assigned to *Ailsastra*, five of them new. O'Loughlin & Rowe (2006) revised the genus *Aquilonastra*. A key to the then 25 species assigned to *Aquilonastra*, and map of type localities, were provided.

Subsequently two additional species of *Aquilonastra* were described: *Aquilonastra shirleyae* O'Loughlin, 2009 (100 m, Point Cloates, Western Australia); *Aquilonastra chantalae* O'Loughlin & Mackenzie, 2013 (shallows, Europa Island, Mozambique Channel). In this paper we are referring four small seastar specimens from the Woodside Kimberley Survey 2010 to two additional new species of *Aquilonastra*. We update the key here to include *A. shirleyae*, *A. chantalae*, and the two new species described below.

Methods

The small seastar specimens were collected incidentally during an intensive search for crustacean and polychaete specimens. They were preserved immediately and directly in 90+% ethanol. No notes of live colour or photos were taken. For photography purposes the preserved specimens were allowed to partly air-dry. Photographs were taken using a Cannon 5D Mark II camera with a Cannon 65 mm macro lens. Series of photographs were taken and stacked using the Zerene Stacker software.

After assembling the whole specimen montage photographs, a ray from each of three specimens was cut off for the purpose of observing external and internal skeletal structure. The distal end of each of these three cut-off arms was cleared briefly in bleach and then washed in water. Photographs were taken to show internal skeletal structures.

Definitions and illustrations of terms

For definitions and illustrations of terms used, such as superactinal plates, superambulacral plates and splay-pointed spinelets, see O'Loughlin & Waters (2004).

Abbreviations

NMV Museum Victoria, with specimen registration number prefix F.
WAM Western Australian Museum, with registration number prefix Z.

Key (see Remarks) to the species assigned to *Aquilonastra* O'Loughlin (in O'Loughlin & Waters 2004) (revised from the key in O'Loughlin & Rowe 2006).

1. Typically 5 equal or subequal rays, sometimes 6 or 4; form symmetrical or near symmetrical; single conspicuous madreporite, rarely 2, very rarely 3; not fissiparous 2
 - Typically 5 or more rays, up to 9, in unequal size groups; form asymmetrical; always more than 1 inconspicuous madreporite; fissiparous 20
2. Gonopores actinal (clearly evident) 3
 - Gonopores abactinal (sometimes obscured) 5
3. One ray may be distinctly shorter; abactinal plates paxilliform; spinelets in dense, frequently crescentiform, clusters; spinelets pencil-like *A. scobinata* (Livingstone, 1933) (SE Australia)
 - Rays subequal; abactinal plates not paxilliform; spinelets not in dense clusters; spinelets not pencil-like 4
4. Abactinal plates with low rounded elevations; spinelets subpaxilliform; maximum R = 9 mm *A. minor* (Hayashi, 1974) (Japan)
 - Abactinal plates lacking rounded elevations; spinelets not subpaxilliform; maximum R = 15 mm *A. byrneae* O'Loughlin & Rowe, 2006 (NE Australia, Mariana Is.)
5. Abactinal spinelets in uniform dense round paxilliform clusters *A. rosea* (H. L. Clark, 1938) (SW Australia)
 - Abactinal spinelets not in uniform dense paxilliform clusters 6
6. Abactinal pedicellariae with conspicuous toothed valves present, larger than spinelets; each oral plate with up to 10 spines 7
 - If abactinal pedicellariae present, valves not larger than spinelets; each oral plate with less than 10 spines 8
7. Up to R = 23 mm; shallow concave interradial margin, rays not discrete; disc clearly defined by 5 wide interradial plates and 5 small interradial plates; spinelets long, thin, pencil-like; actinal interradial spines up to 4 per plate *A. rowleyi* O'Loughlin & Rowe, 2006 (SE Africa)
 - Up to R = 13 mm; form stellate, rays discrete; disc not clearly defined; spinelets columnar or conical centrally, splay-pointed distally; actinal interradial spines up to 10 per plate *A. shirleyae* O'Loughlin, 2009 (WA, Point Cloates, 100 m)
8. Abactinal spinelets on rays typically differentiated on plates into apical and marginal forms; some irregularly distributed paxilliform plates 9
 - Abactinal spinelets may be of variable form, but not typically differentiated on plates into apical and marginal forms; lacking any paxilliform abactinal plates 10
9. Abactinal radial plates with apical subglobose spinelets, peripheral short conical to subgranuliform spinelets; lacking pedicellariae; actinal central interradial plates each with about 3 spines *A. lorioli* (Koehler, 1910) (N Indian Ocean)
 - Abactinal radial plates with apical digitiform spinelets, peripheral short conical spinelets; pedicellariae frequently present; actinal central interradial plates each with about 5 spines *A. coronata* (Martens, 1866) (Japan to N Australia)
10. Pedicellariae with differentiated valves in abactinal proximal interradial evident in larger specimens 11
 - Lacking pedicellariae 14
11. Abactinal spinelets up to about 12 on each proximal carinal plate (at R = 20 mm) *A. iranica* (Mortensen, 1940) (Persian Gulf)
 - Abactinal spinelets up to about 20 and more on each proximal carinal plate (at R = 17 mm) 12
12. Abactinal proximal spinelets up to about 40 per plate; superomarginal plates each with up to about 20 spinelets (at R = 19 mm) *A. batheri* (Goto, 1914) (Japan)
 - Abactinal proximal spinelets up to about 20 per plate; superomarginal plates each with up to about 7 spinelets (at R = 19 mm) 13
13. Abactinal distal interradial plate spinelets splayed and overlapping adjacent plate spinelets (at R = 20 mm); actinal interradial plates each with up to 5 spines (at R = 20 mm); size up to R = 25 mm *A. richmondi* O'Loughlin & Rowe, 2006 (E Africa coast, Madagascar, Mauritius)
 - Abactinal distal interradial spinelets not overlapping adjacent plate spinelets if splayed; actinal interradial plates each with up to 8 spines (at R = 19 mm); size up to R = 19 mm *A. watersi* O'Loughlin & Rowe, 2006 (Arabian Sea, Mauritius)
14. Abactinal spinelets sacciform, short, widely globose basally, tapered to sharply pointed apically; predominantly 2 actinal interradial spines on each plate *A. halseyae* O'Loughlin & Rowe, 2006 (Maldives)

- Abactinal spinelets not widely globose basally, not tapered to a sharp point apically; predominantly > 3 actinal interradial spines on each plate 15
 - 15. Abactinal spinelets short, thick, columnar or conical 16
 - Abactinal spinelets long, subsacciform to splay-pointed 17
 - 16. Rays long, subdigitiform; spinelets mostly spread over exposed plate surface; predominantly 6 spines per actinal interradial plate (at R = 16 mm). *A. samyni* O'Loughlin & Rowe, 2006 (Arabian Sea to SE Africa, Madagascar, La Réunion)
 - Rays short, strongly tapered; spinelets mostly concentrated over projecting proximal plate edge; predominantly 3 spines per actinal interradial plate (at R = 16 mm) *A. marshae* O'Loughlin & Rowe, 2006 (Red Sea, Gulfs of Aqaba and Suez)
 - 17. Rays short; lacking doubly-papulate carinal plates; spinelets not clustered into groups on plates; spinelets frequently splay-pointed 18
 - Rays long, discrete; some doubly-papulate carinal plates may be present; spinelets frequently clustered into groups on plates; spinelets not splay-pointed 19
 - 18. Rays 5; up to R = 12 mm; rays merge basally; up to 14 spinelets per abactinal plate *A. oharai* O'Loughlin & Rowe, 2006 (Okinawa)
 - Rays 6; up to R = 6 mm; rays with sub-acute join basally; up to 10 spinelets per abactinal plate *A. alisonae* sp. nov. (north Western Australia)
 - 19. Rays tapered; abactinal plates angled over papulae; spinelets long, thin, sub-sacciform to sacciform, tapering to fine point, rugose, subacicular; spinelets frequently projecting proximally over papulae *A. cepheus* (Müller & Troschel, 1842) (Indonesia to N Australia)
 - Rays digitiform; abactinal plates not angled over papulae; spinelets long, thick, conical to subsacciform, with numerous (5–6) points on distal sides and end of spinelets; spinelets not projecting proximally over papulae *A. limboonkengi* (Smith, 1927) (China)
 - 20. Actinal interradial spines predominantly 1 per plate 21
 - Actinal interradial spines predominantly > 1 per plate 22
 - 21. Up to R = 10 mm; at R = 4 mm rays 6–8; abactinal spinelets mostly granuliform; actinal interradial spines short, thick, conical to subsacciform, pointed distally *A. conandae* O'Loughlin & Rowe, 2006 (Indian Ocean, Mascarene Is.)
 - Up to R = 4 mm; at R = 4 mm rays 5 (smaller specimens up to 7 rays); abactinal spinelets mostly digitiform; actinal interradial spines predominantly subsacciform, spinous distally *A. chantalae* O'Loughlin & Mackenzie, 2013 (Mozambique Channel)
 - 22. Spinelets of 2 distinct forms, long thick digitiform apically on upper ray and marginal plates, smaller conical below apex of plates *A. corallicola* (Marsh, 1977) (NE Indian to central W Pacific Oceans)
 - Spinelets of one form 23
 - 23. Spinelets elongate, not granuliform or subgranuliform (at R = 5 mm) 24
 - Spinelets truncate, small, subgranuliform or granuliform (at R = 5 mm) 27
 - 24. Up to 8 rays; upper abactinal spinelets conical to prominently splay-pointed sacciform; pedicellariae sometimes present, valves larger than spinelets; size up to R = 12.5 mm *A. anomala* (H. L. Clark, 1921) (central W Pacific)
 - Up to 7 rays; upper abactinal spinelets not distinctly splay-pointed; lacking pedicellariae; size up to R = 7 mm 25
 - 25. Oral spines 3–4 per plate; suboral spines 0–1 per plate; size up to R = 7 mm *A. cassini* sp. nov. (north Western Australia)
 - Oral spines 5 or 6 per plate; suboral spines 3 per plate; size up to R = 5 mm 26
 - 26. Rays elevated; spinelets thick columnar or conical; actinal interradial spines up to 2 per plate; actinal spines bluntly pointed conical to digitiform *A. colemani* O'Loughlin & Rowe, 2006 (Papua New Guinea, Indonesia)
 - Rays not elevated; spinelets thin digitiform or conical with distally long spines; actinal interradial spines up to 5 per plate; actinal spines long, conical, thin, finely tapered *A. doranae* O'Loughlin & Rowe, 2006 (Okinawa)
 - 27. Size up to R = 18 mm; some central abactinal plates atypically large and irregular *A. burtonii* (Gray, 1840) (Red and Arabian Seas)
 - Size up to R = 9 mm; central abactinal plates not unusually large and irregular 28
 - 28. Up to 8 rays; up to R = 7 mm; spinelets up to 16 per plate; suboral spines up to 4 per plate *A. yairi* O'Loughlin & Rowe, 2006 (Red and Mediterranean Seas)
 - Up to 7 rays; up to R = 9 mm; spinelets up to 10 per plate; suboral spines up to 2 per plate *A. moosleitneri* O'Loughlin & Rowe, 2006 (Maldives Is.)
- Remarks.* We acknowledge some difficulties with the key, such as splitting the species into fissiparous and not fissiparous. We are aware, for example, that asteroids may be fissiparous when juvenile but not when adult. This is the case with the asteriid *Coscinasterias muricata* Verrill, 1867 (personal observations). Thus the slight asymmetry in the type specimens of *Aquilonastra alisonae* sp. nov. may reflect an earlier juvenile fissiparous stage. Likewise there may be difficulty in detecting the site of gonopores, or whether they are present. We judge that if they are actinal they will be readily seen, whereas abactinally they are often obscured by spinelets and amongst

papulae and an assumption has to be made about the site of their occurrence. Pedicellariae are sometimes difficult to detect, especially if the valves are undifferentiated abactinal spinelets. Judgments, such as the form of spinelets, are somewhat subjective. And the forms of some morphological

characters overlap. We recommend that the key should be used in conjunction with the illustrations of *Aquilonastra* species in O'Loughlin & Rowe (2006), O'Loughlin (2009) and O'Loughlin & Mackenzie (2013).

Table. WAM specimens of seastar species assigned to *Aquilonastra* from the Kimberley Project Area (see map in Sampey *et al.* 2014)

Taxon	Some distinguishing species characters (See O'Loughlin & Rowe 2006)	Kimberley Project Area & WAM Registration
<i>Aq. alisonae</i> sp. nov.	6 rays; not fissiparous; lacking pedicellariae; splay-pointed spinelets	Long Reef: WAM Z26199, WAM Z26200
<i>Aq. anomala</i> (H. L. Clark, 1921)	up to 8 rays; fissiparous; pedicellariae present; frequently splay-pointed spinelets	Long Reef: WAM Z6843; Ashmore Reef: WAM Z6844; Cartier Island: WAM Z6846; North Scott Reef: WAM Z6847; Mermaid Reef: WAM Z50826, WAM Z50827
<i>Aq. cassini</i> sp. nov.	5–6 rays; fissiparous; lacking pedicellariae; mostly conical spinelets	Cassini Island: WAM Z26198, WAM Z26201
<i>Aq. cepheus</i> (Müller & Troschel, 1842)	5 rays, sometimes 6 or 4; not fissiparous; spinelets subacicular, subsacciform	King Sound: WAM Z6842; Ashmore Reef: WAM Z6879, WAM Z6880, WAM Z6881, WAM Z68030, WAM Z68038; Scott Reef: WAM Z6882, WAM Z6883, WAM Z6884, WAM Z6885, WAM Z6887; Cartier Island: WAM Z6886
<i>Aq. coronata</i> (von Martens, 1866)	5 rays; not fissiparous; paxilliform abactinal plates; 2 forms of spinelet	Mission Bay: WAM Z6890; Admiralty Bay: WAM Z6896; Storr Island: WAM Z6897; One Arm Point: WAM Z6898, WAM Z6899; Naturalist Island: WAM Z6900; Wailgwin Island: WAM Z58338

Asterinidae Gray, 1840

Synonymy. See Clark and Downey, 1992.

Diagnosis. See Clark and Downey, 1992.

Remarks. For a recent revision of Asterinidae see O'Loughlin & Waters (2004). For the addition of a new genus *Ailsastra* see O'Loughlin & Rowe (2005).

Aquilonastra O'Loughlin, 2004 (in O'Loughlin & Waters, 2004)

Aquilonastra O'Loughlin, in O'Loughlin & Waters, 2004: 5 (key), 13–15, tables 1, 2.—O'Loughlin & Rowe, 2005: 181.—Saba & Fujita, 2006: 270.—Byrne, 2006: 244, 245, 248, 250, 251.—O'Loughlin & Rowe, 2006: 257–287.—O'Loughlin, 2009: 204, fig. 1.—O'Loughlin & Mackenzie, 2013: 177–180, figs 1, 2.

Diagnosis (from O'Loughlin & Mackenzie 2013). Rays 5, or 5–8 in fissiparous species; inter-radial margin deeply incurved, form stellate; rays discrete, broad at base, tapering, rounded distally; flat actinally, convex abactinally; abactinal plates in longitudinal series, not perpendicular to margin; papulate areas extensive; papulae predominantly single, large, in longitudinal series along sides of rays; abactinal plates with glassy convexities; abactinal spinelets and actinal spines predominantly fine, glassy, conical

or sacciform or splay-pointed sacciform, in bands or tufts, numerous (10–40 per plate); actinal plates in longitudinal, sometimes oblique, series; superambulacral plates present for all of ray, sometimes for part of ray or absent in pedomorphic species; superactinal plates present.

Remarks. We have deleted the word “high” in relation to convex from the diagnosis in O'Loughlin & Mackenzie (2013) since “high” lacks clear meaning, and have replaced “not oblique” in relation to actinal plate arrangement with “sometimes oblique” to accord with our observations in this work.

Aquilonastra alisonae sp. nov.

Zoobank LSID. <http://zoobank.org/urn:lsid:zoobank.org:act:727C2763-A5B6-463A-B184-94572BD2B4F5>

Figures 1–4, key, table.

Material examined. Holotype. North Western Australia, Kimberley Region, *Woodside Collection Project* (Kimberley) 2008–2015, station 56/K10, Long Reef, 13.95704 S -125.71846 E, rock substrate, intertidal, coll. A. Sampey *et al.*, 24 Oct 2010, WAM Z26200 (one ray abnormal; one ray cut off mid-ray and cleared).

Paratype. *Woodside Collection Project* (Kimberley) 2008–2015, station 47/K10, Long Reef, 13.81995 S -125.74942 E, rock substrate, fore reef, 6 m, coll. S. Woolley, 21 Oct 2010, WAM Z26199 (1).

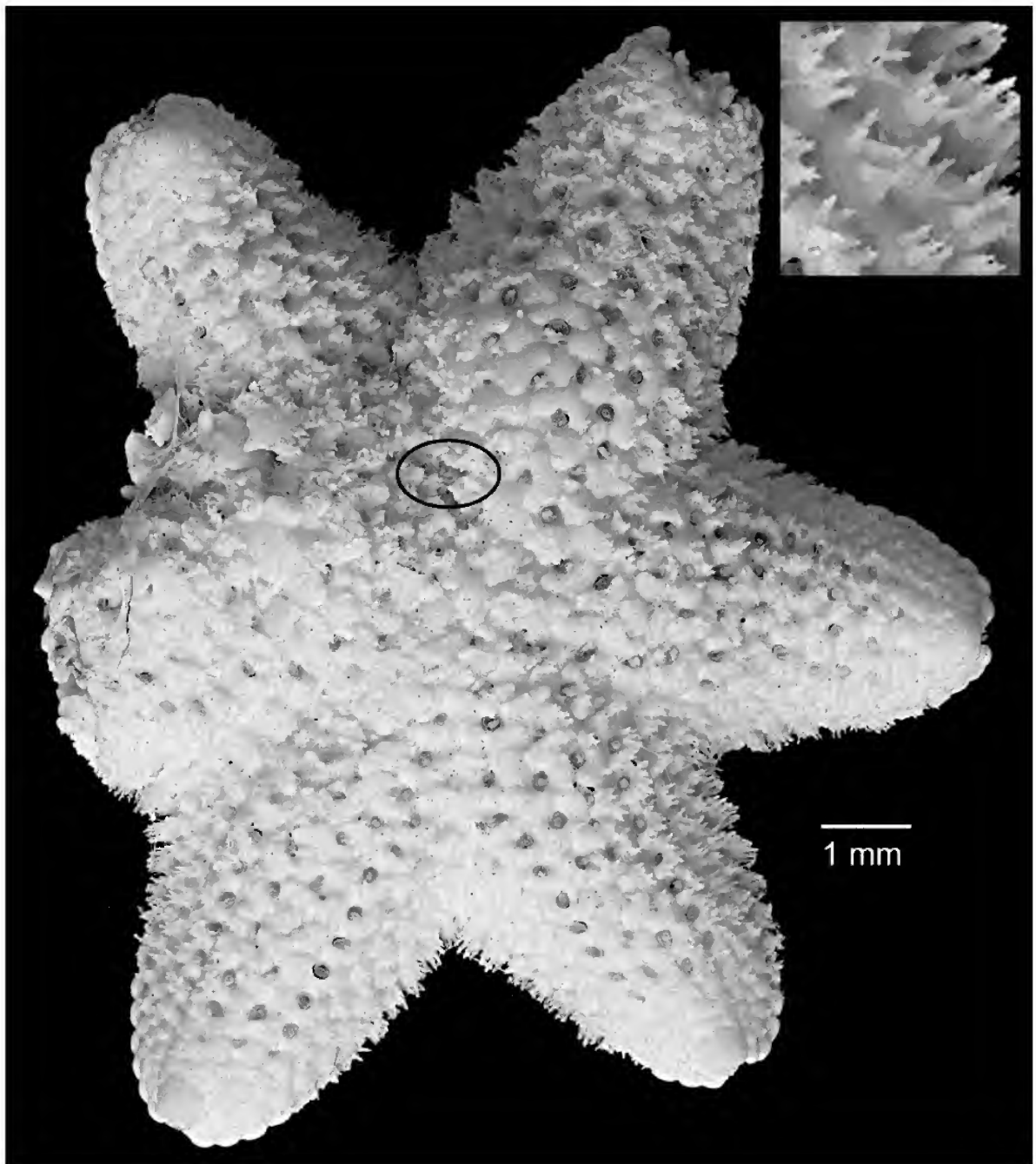


Figure 1. Montage photograph of the holotype of *Aquilonastra alisonae* sp. nov. (WAM Z26200). Abactinal view showing six subequal rays (one abnormal), abactinal plates irregular in form and arrangement, plates on upper rays singly papulate in predominantly four longitudinal series per ray. Single madreporite highlighted. Insert (upper right) with splay-pointed abactinal spinelets from the lower ray and margin.

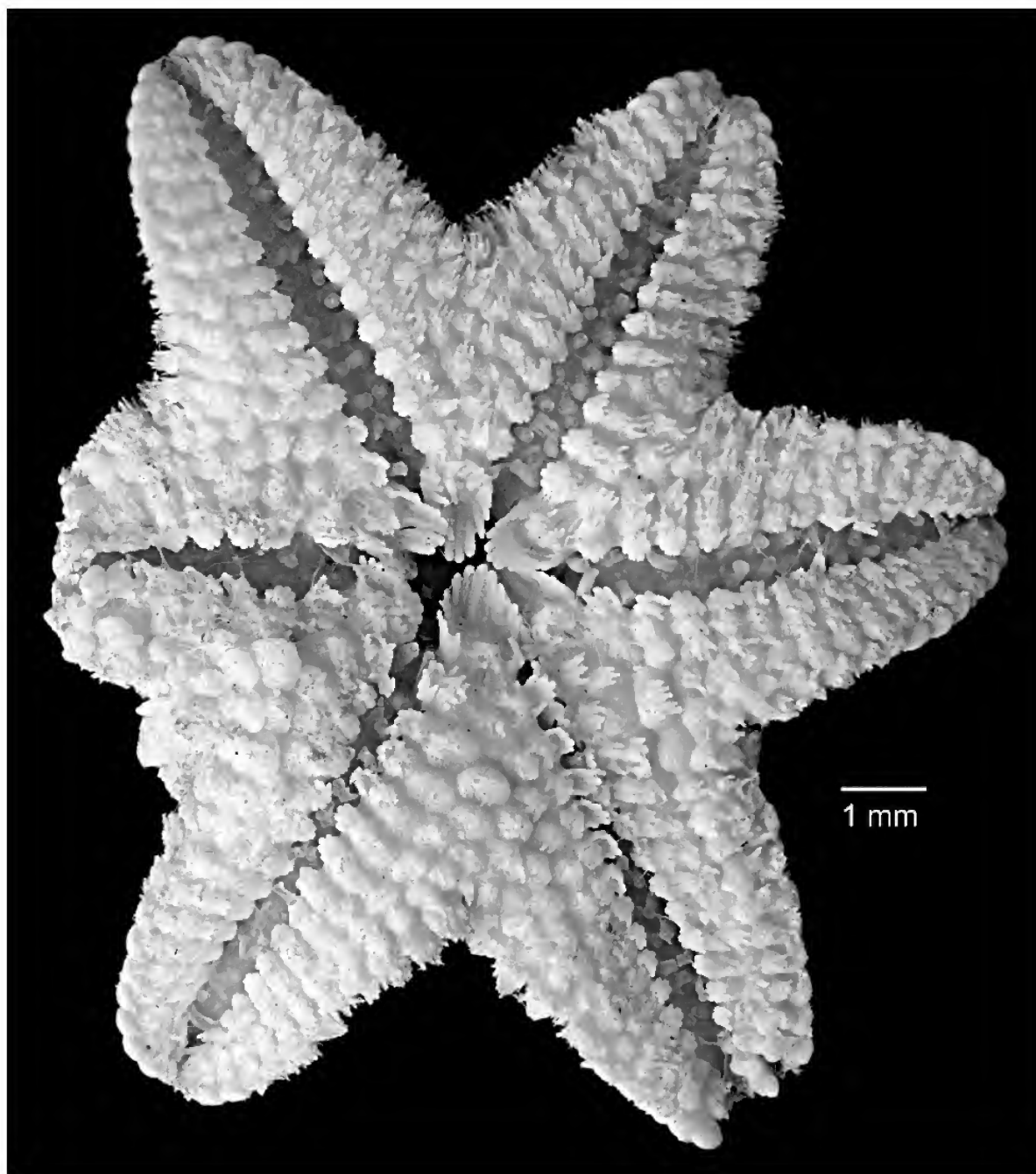


Figure 2. Montage photograph of the holotype of *Aquilonastra alisonae* sp. nov. (WAM Z26200). Actinal view showing six rays and spination and actinal plates in slightly irregular longitudinal and oblique series.

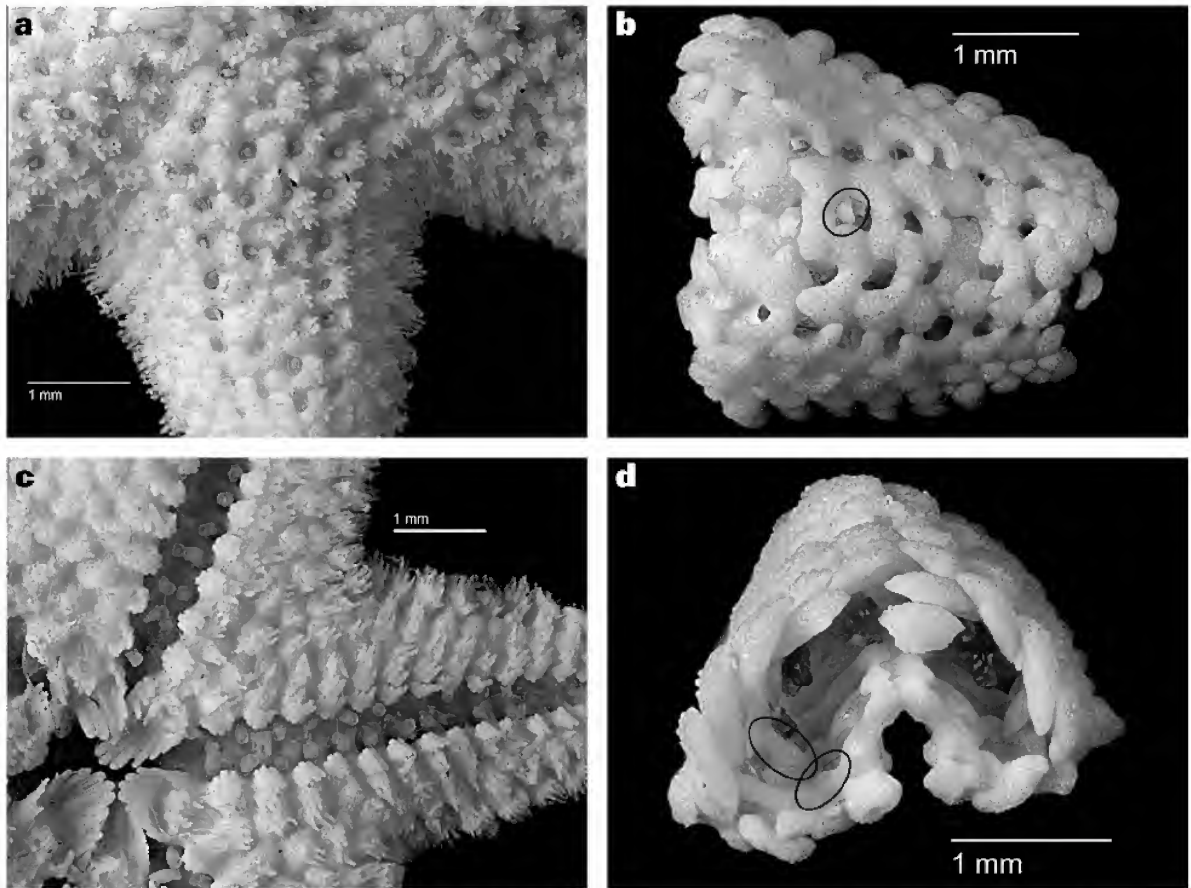


Figure 3. Montage photographs of the holotype of *Aquilonastra alisonae* sp. nov. (WAM Z26200). a, abactinal proximal view of a ray showing irregular plate forms and arrangement and predominantly splay-pointed spinelets; b, abactinal view of a distal cleared ray showing glassy convexities on plates, proximal concave indentation on some plates for a papula, and a secondary plate highlighted; c, actinal view of the oral region and proximal ray; d, view of internal skeletal structure of a cleared ray with a superactinal plate (left) and a superambulacral plate (right) highlighted.

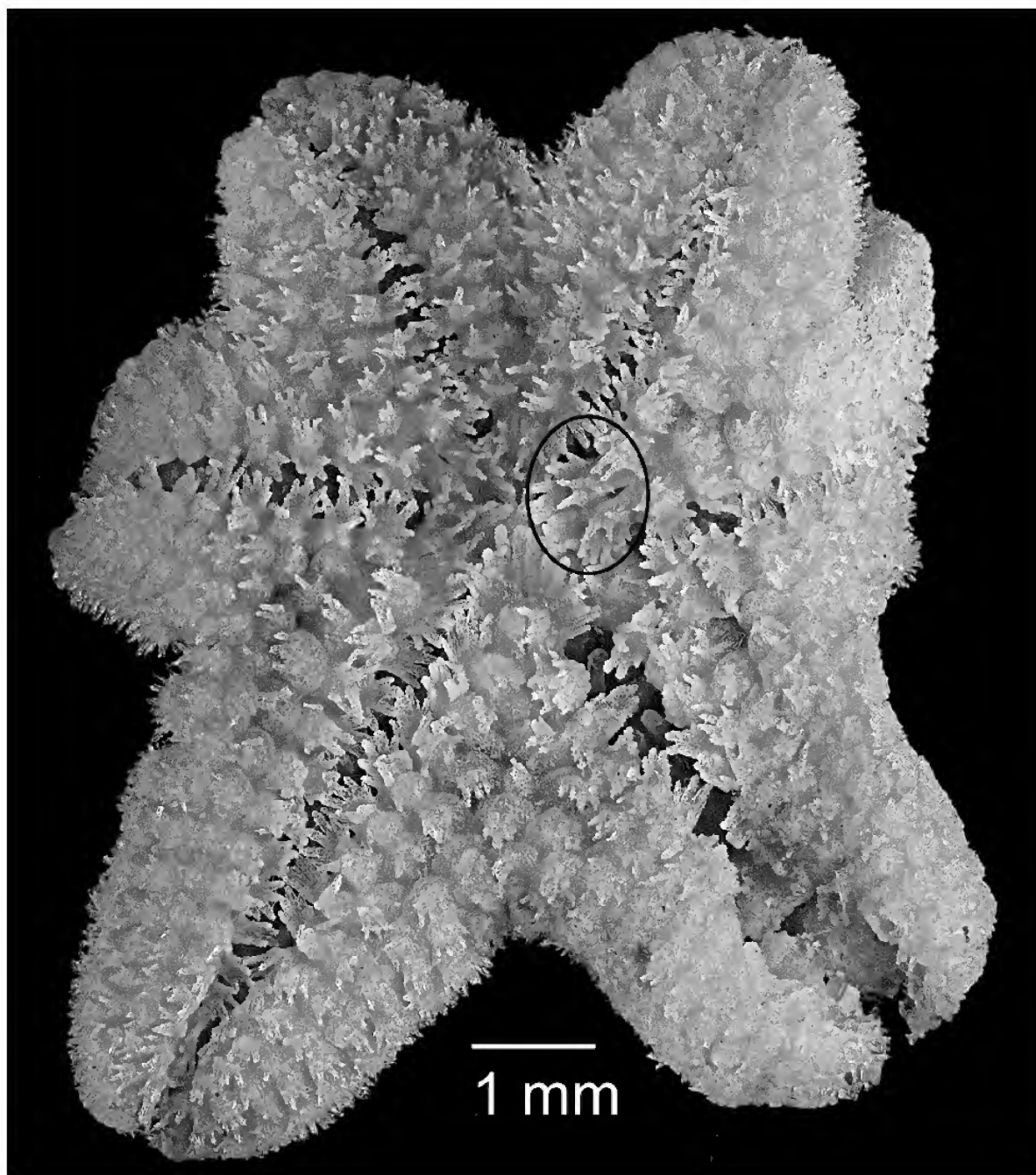


Figure 4. Montage photograph of a paratype of *Aquilonastra alisonae* sp. nov. (WAM Z26199). Actinal view showing six rays and spine forms and numbers that are similar to those of the holotype. Two oral plates highlighted, with 6 oral spines each, and four distal suboral spines each (proximal two large and distal two small).

Description. Asterinid seastar, six rays, variably slightly unequal, rays wide basally, tapered to rounded end distally, up to $R = 6.2$ mm, $r = 3.0$ mm, rays merging at bases, inter-radial junction of rays sub-acute, rays low convex abactinally, rays flat actinally, margin acute. Madreporite large, conspicuous, only one detected on holotype, above junction of bases of two rays. Not fissiparous. Disc not discretely demarcated. No abactinal or actinal gonopores detected. Pedicellariae not detected. Glassy convexities on cleared abactinal and actinal plates. Superomarginal and inferomarginal plates subequal; inferomarginal plates not projecting noticeably. Internal superambulacral and superactinal plates present.

Abactinal surface: disc plates imbricate irregularly with those of rays; upper ray plates irregular in form, not in regular series, no carinal series of plates; most upper ray plates widely concave proximally to create papular space; single papula per papular space; rare secondary plates; 4 prominent longitudinal series of papulae across rays, short lower series of smaller papulae along rays, up to 11 papulae per series along upper ray, series along upper part of ray irregular; up to about 10 predominantly splay-pointed spinelets per abactinal plate, frequently in 2 transverse series across proximal edge and middle of plate; superomarginal plates with up to 8 splay-pointed spinelets per plate in 2 series of 5 distal and 3 proximal.

Actinal surface spines per plate: oral 6, long, thin, slightly cylindrical to spatulate; sub-oral 4–3; furrow 5, digitiform; subambulacral 4, digitiform to splay-pointed; actinal up to 7 on central plates, conical to splay-pointed; inferomarginal up to about 9, predominantly splay-pointed, frequently with 6 abactinal inferomarginal, 3 actinal inferomarginal. Actinal inter-radial plates in slightly irregular longitudinal and oblique series.

Distribution. North Western Australia, Kimberley Region, Long Reef, rock substrate, 0–6 m.

Etymology. Named for Alison Sampey, formerly of WAM, who initially collected and curated these specimens.

Remarks. The slightly irregular length of the six rays and irregular plate arrangement on disc and upper rays prompted us to think initially that this species is fissiparous. But the presence of only one conspicuous madreporite, and only slight ray length differences lead us to judge that the species is not fissiparous, at least for the size of the two type specimens. *Aquilonastra alisonae* sp. nov. is distinguished diagnostically from other *Aquilonastra* species in the key. It differs in particular from other species of *Aquilonastra* from the Kimberley region by having a combination of: six rays; predominantly splay-pointed abactinal spinelets; single madreporite; non-fissiparous habit; absence of pedicellariae. We did not observe gonopores, but they were clearly not present actinally and assume that they would be abactinal if present.

Aquilonastra cassini sp. nov.

Zoobank LSID. <http://zoobank.org/urn:lsid:zoobank.org:act:EBFF184D-ADAE-4C5C-AA63-619D69B4AE4A>

Figures 5–8, key, table.

Material examined. Holotype. North Western Australia, Kimberley Region, Woodside Collection Project (Kimberley) 2008–2015,

station 37/K10, Cassini I., 13.95156S -125.624123E, rock substrate, 3 m, coll. L. Walker, 18 Oct 2010, WAM Z26198 (one ray cut off proximally and cleared).

Paratype. Woodside Collection Project (Kimberley) 2008–2015, station 33/K10 (see database), Cassini Island, 13.92816 S -125.62337 E, lagoon, rock substrate, 1.8 m, coll. A. Sampey *et al.*, 17 Oct 2010, WAM Z26201 (1) (one ray cut off proximally and cleared).

Description. Asterinid seastar, asymmetrical, five or 6 sub-equal rays, sub-digitiform, narrow and rounded distally, slightly widened basally, up to $R = 7.0$ mm, $r = 2.5$ mm, rays merging at bases, inter-radial junction of rays sub-acute, rays low convex abactinally, rays slightly convex actinally, margin acute. Disc not discretely demarcated. Three small, inconspicuous, abactinal madreporites seen on holotype. Fissiparous. No abactinal or actinal gonopores detected. Pedicellariae not detected. Glassy convexities on cleared abactinal and actinal plates. Inferomarginal plates significantly larger than superomarginal plates; inferomarginal plates project noticeably at margin. Internal superambulacral and superactinal plates present.

Abactinal surface: disc plates imbricate irregularly with those of upper rays; upper ray plates proximal to disc irregular; lacking secondary plates; regular carinal series of plates along some upper rays only, up to 11 carinal plates per series, each carinal plate with paired deep lateral notches to create paired single papular spaces; plates on sides of rays with single papular space; single series of papulae adcarinally on rays, up to 15 per series, short lower series of smaller papulae along rays, 4 prominent longitudinal series of papulae across rays; abactinal spinelets predominantly conical; disc with 6–3 spinelets per plate, each carinal plate with cluster of 5–3 spinelets on crown of plate, adcarinal plates with up to 7 spinelets across angled plate, proximal and distal inter-radial abactinal plates with predominantly 4 spinelets, variably 6–3, conical to splay-pointed; superomarginal plates with 5–4 splay-pointed spinelets per plate.

Actinal surface spines per plate: oral 4–3, sub-oral 1–0, digitiform, slightly spatulate, with minute distal spinelets; proximal furrow 4–3, subambulacral 3–2; actinal predominantly 4, conical form with pointed distal end; inferomarginal up to about 11, predominantly splay-pointed, frequently with 2 and 6 abactinal inferomarginal groups, 3 conical actinal inferomarginals. Actinal plates in longitudinal and more noticeably oblique series.

Distribution. North Western Australia, Kimberley Region, Cassini Island, rock substrate, 1.8–3 m.

Etymology. Named *cassini* (in apposition) for the type locality, Cassini Island, in the Kimberley Region of north Western Australia.

Remarks. The subequal ray lengths of the five-rayed holotype prompted us to not think fissiparity for this species. But the presence of three small madreporites on the holotype, and irregular abactinal plate arrangement, lead us to conclude that this species is fissiparous. It differs in particular from other species of *Aquilonastra* from the Kimberley region by having a combination of: 5–6 rays; predominantly conical abactinal spinelets; up to 3 madreporites; fissiparous habit; absence of pedicellariae.

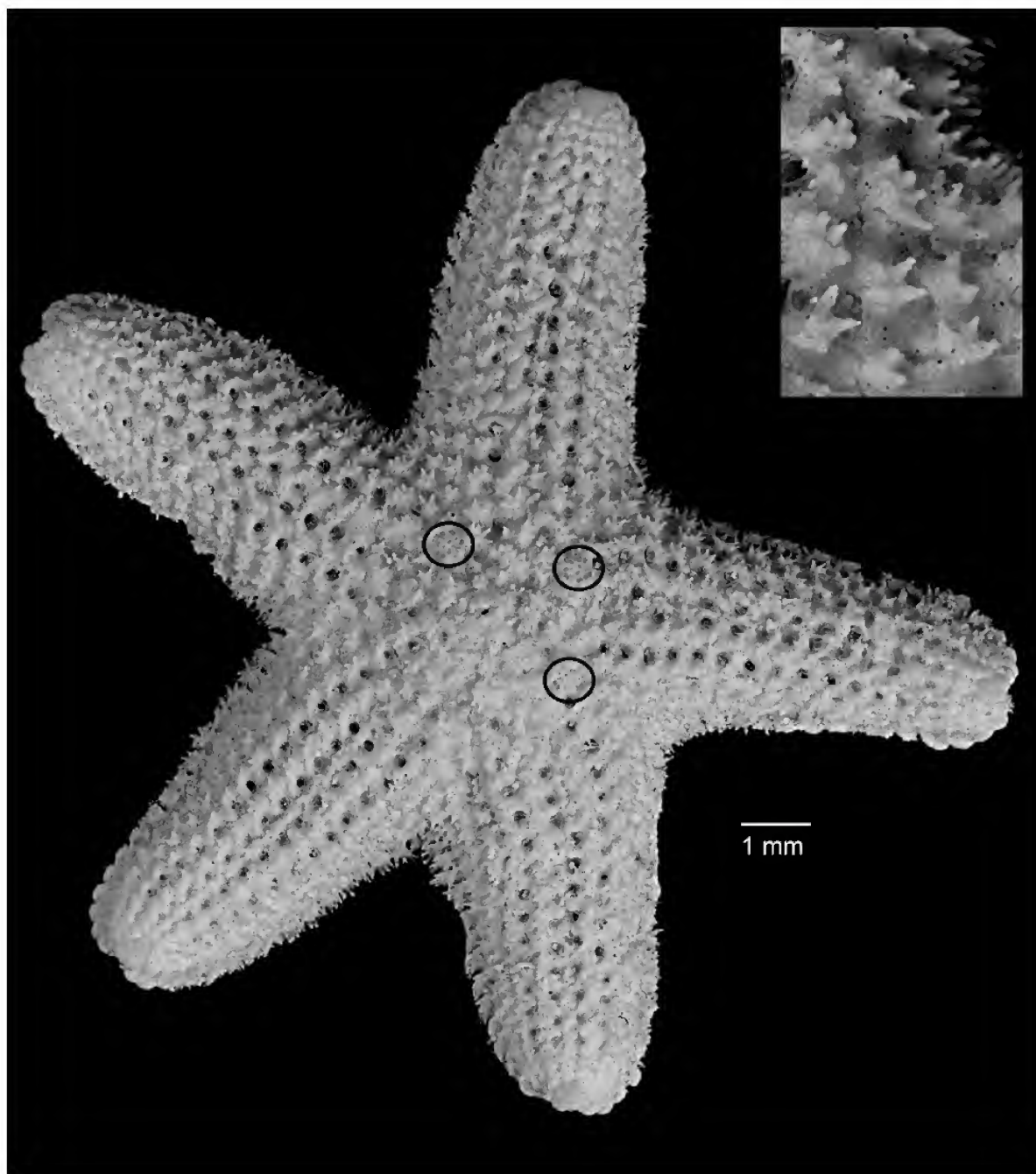


Figure 5. Montage photograph of the holotype of *Aquilonastra cassini* sp. nov. (WAM Z26198). Abactinal view showing five subequal rays; long carinal series on bottom left ray; disc not discretely delineated; three small madreporites highlighted. Insert (upper right) with predominantly conical spinelets from an abactinal lower ray and margin. The fine black spots on the specimen are contaminating grit.

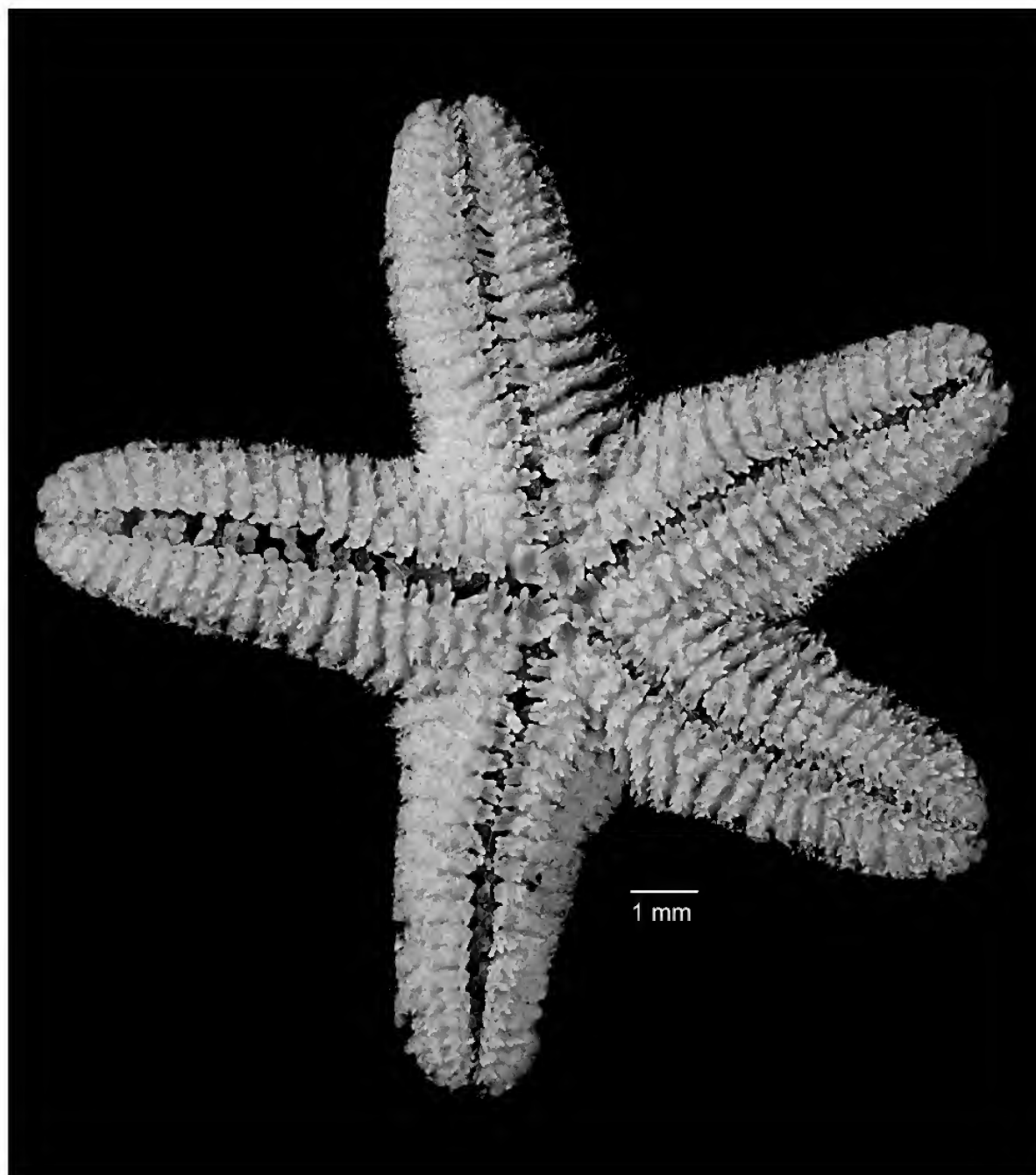


Figure 6. Montage photograph of the holotype of *Aquilonastra cassini* sp. nov. (WAM Z26198). Actinal view showing the oblique and longitudinal arrangement of the actinal plates, and the actinal spination.

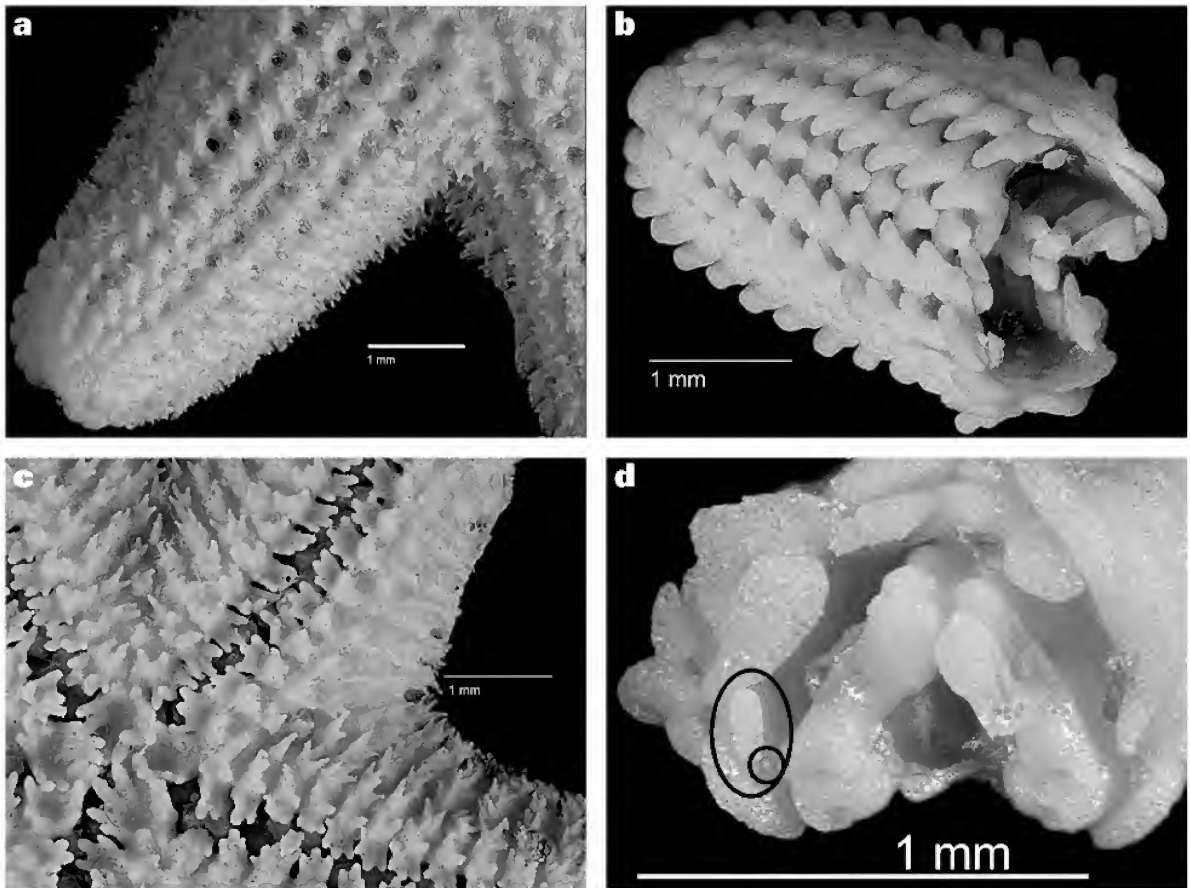


Figure 7. a–c, montage photographs of the holotype of *Aquilonastra cassini* sp. nov. (WAM Z26198). a, abactinal view of a ray showing a long carinal series of plates along the upper ray; b, abactinal view of a distal cleared ray showing the doubly papulate carinal series of plates, absence of secondary plates, and projecting inferomarginal plates; c, actinal view of the oral region and a proximal ray; d, montage photograph of a cleared distal ray of the paratype of *Aquilonastra cassini* sp. nov. (WAM Z26201). d, view of the internal skeletal structure of a ray with a superactinal plate (highlighted left) and probably an incipient minute superambulacral plate (highlighted within).

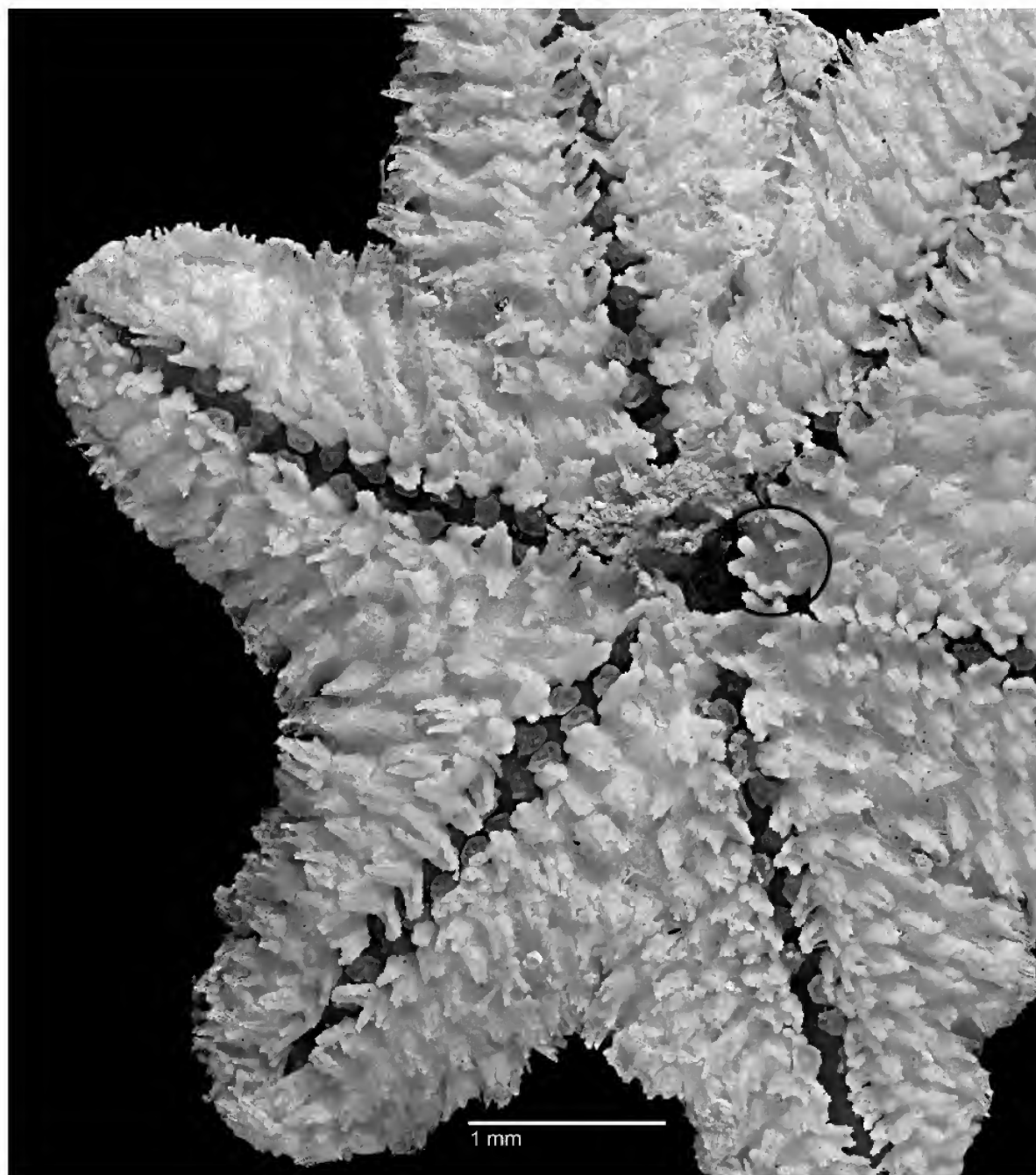


Figure 8. Montage photograph of the paratype of *Aquilonastra cassini* sp. nov. (WAM Z26201). Actinal view with pair of oral plates highlighted and showing three oral and single suboral spines, all spines with minute distal spinelets.

Acknowledgements

We are grateful to: Ben Boonen for his skilled assistance with the format of the figures; Jane Fromont (WAM) and Mark Salotti (WAM) for their gracious assistance with loan material and data; David Paul (NMV) for his most helpful assistance with photography; Alison Sampey for her initial collection and curation of the specimens; the staff of the marine invertebrate department of Museum Victoria for the facilitation of resources for this study. The authors thank the Woodside Energy Ltd./WA Museum Partnership for the collection of specimens described in this paper. We are grateful to Melanie Mackenzie (NMV) for a most helpful review of our paper.

References

- Byrne, M. 2006. Life history diversity and evolution in the Asterinidae. *Integrative and Comparative Biology* 46(3): 243–254.
- Clark, A. M., & Downey, M. E. 1992. *Starfishes of the Atlantic*. Chapman and Hall (Natural History Museum Publications): London. 794 pp, 75 figs, 113 pls.
- Clark, H. L. 1921. The echinoderm fauna of Torres Strait: its composition and its origin. *Publication of the Carnegie Institution of Washington No. 214*: i–viii, 1–223 pp, 38 pls.
- Clark, H. L. 1938. Echinoderms from Australia. An account of collections made in 1929 and 1932. *Memoirs of the Museum of Comparative Zoology at Harvard College* 55: 1–596, 28 pls, 63 figs.
- Goto, S. 1914. A descriptive monograph of Japanese Asteroidea. *Journal of the College of Science, Imperial University of Tokyo* 9(1): 1–808, 19 pls.
- Gray, J. E. 1840. A synopsis of the genera and species of the class Hypostoma (Asterias Linnaeus). *Annals and Magazine of Natural History* (1) 6: 175–184; 275–290.
- Hayashi, R. 1974. A new sea-star from Japan, *Asterina minor* sp. nov.. *Proceedings of the Japanese Society of Systematic Zoology* 10: 41–44.
- Koehler, R. 1910. An account of the shallow-water Asteroidea. *Echinoderma of the Indian Museum* 6(2): 1–183, pls 1–20.
- Livingstone, A. A. 1933. Some genera and species of the Asterinidae. *Records of the Australian Museum* 19: 1–20, pls 1–5.
- Marsh, L.M. 1977. Coral reef asteroids of Palau. *Micronesica* 13(2): 251–282.
- Martens von, E. 1866. Ueber ostasiatische Echinodermen 3. Seesterne des indischen Archipels. *Archiv für Naturgeschichte* 32: 57–92.
- Mortensen, Th. 1940. Echinoderms from the Iranian Gulf. *Danish Scientific Investigations in Iran* 2: 55–112, pls 1, 2. Ejnar Munksgaard: Copenhagen.
- Müller, J. & Troschel, F. H. 1842. *System der Asteriden*. xx+134 pp, 12 pls. Braunschweig.
- O'Loughlin, P. M. 2009. New asterinid species from Africa and Australia (Echinodermata: Asteroidea: Asterinidae). *Memoirs of Museum Victoria* 66: 203–213.
- O'Loughlin, P. M. & Mackenzie, M. 2013. Asterinid seastars from the Mozambique Channel (Echinodermata: Asteroidea: Asterinidae). *Zootaxa* 3613 (2): 176–180.
- O'Loughlin, P. M. & Rowe, F. W. E. 2005. A new asterinid genus from the Indo-West Pacific region, including five new species (Echinodermata: Asteroidea: Asterinidae). *Memoirs of Museum Victoria* 62(2): 181–189.
- O'Loughlin, P. M. & Rowe, F. W. E. 2006. A systematic revision of the asterinid genus *Aquilonastra* O'Loughlin, 2004 (Echinodermata: Asteroidea). *Memoirs of Museum Victoria* 63(2): 257–287.
- O'Loughlin, P. M. & Waters, J. M. 2004. A molecular and morphological revision of genera of Asterinidae (Echinodermata: Asteroidea). *Memoirs of Museum Victoria* 61(1): 1–40.
- Saba, M. & Fujita, T. 2006. Asteroidea (Echinodermata) from the Sagami Sea, Central Japan. 1. Paxillosida and Valvatida. *Memoirs of the National Science Museum* 41: 251–287.
- Sampey, A., Bryce, C., Osborne, S & Miles, A. 2014. Kimberley marine biota. Historical data: introduction and methods. *Records of the Western Australian Museum, Supplement* 84: 19–43.
- Sampey, A. & Marsh, L. M. 2015. Kimberley Marine Biota. Historical data: Echinoderms. *Records of the Western Australian Museum, Supplement* 84: 207–246. (in preparation)
- Smith, G.A. 1927. A collection of echinoderms from China. *Annals and Magazine of Natural History* 9(20): 272–279.
- Verrill, A. E. 1867. Notes on the Radiata in the Museum of Yale College, with descriptions of new genera and species. 1. Descriptions of new starfishes from New Zealand. *Transactions of the Connecticut Academy of Arts and Sciences* 1(2)5: 247–251. [Also in: *Transactions and Proceedings of the New Zealand Institute* (1880) 12(34): 278–283]

A new species of *Halopteris* (Hydrozoa: Leptothecata) and redescription of *Plumularia rotunda* from Victoria, Australia

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Abstract

Watson, J.E. 2015. A new species of *Halopteris* (hydrozoa: leptothecata) and redescription of *Plumularia rotunda* from Victoria, Australia. *Memoirs of Museum Victoria* 73: 41–46.

Halopteris urceolata sp. nov. is described from Port Phillip. *Plumularia rotunda* Mulder and Trebilcock, 1911 is redescribed from the adjacent Victorian coast and its relationship to *Plumularia wilsoni* Bale, 1926 discussed.

Keywords

Victorian coast, *Halopteris urceolata* sp. nov., *Plumularia rotunda* Mulder and Trebilcock, 1911, *Plumularia wilsoni* Bale, 1926.

Introduction

This paper reports on three species of hydroids, *Halopteris urceolata* newly described from Port Phillip, Victoria, and *Plumularia rotunda* Mulder and Trebilcock, 1911, poorly known from the central Victorian coast. The status and relationships of *Plumularia rotunda* to a closely related species, *Plumularia wilsoni* Bale, 1926 is examined. Type and voucher material is lodged in Museum Victoria (NMV).

Halopteris urceolata sp. nov.

Figure 1A–F

Material examined. NMV F207310, holotype, malinol mounted microslide, infertile colony on the bryozoan *Amathia tortuosa*, coll: J. Watson, St Leonards pier, Port Phillip, 29/10/2012, depth 2 m; NMV F207310, remainder of holotype colony preserved in 70% ethanol.

Description. Hydrorhiza a smooth tubular stolon of same diameter as stem, running along branches of the bryozoan host, giving off single delicate stems at irregular intervals. Stems to 15 mm high, straight, monosiphonic, cylindrical, with one or two basal ahydrocladial internodes with weakly oblique to transverse nodes, distalmost node strongly oblique, following internodes alternately athecate and thecate, athecate internode with transverse proximal and strongly oblique distal node.

Hydrocladia alternate, planar, basal hydrocladia opposite in some stems. Apophysis of stem cylindrical with transverse distal node. Hydrocladia with up to five hydrothecae, arising from behind frontal cauline hydrotheca, sometimes a short secondary hydrocladium bearing two or three hydrothecae given off from behind first hydrocladial hydrotheca. Hydrocladial internodes alternately athecate and thecate;

thecate internode with oblique nodes, distal node sometimes reduced to a notch in perisarc, athecate internode with a single nematotheca about halfway along internode.

Hydrotheca seated about halfway along thecate internode at an angle of approximately 40° to hydrocladial axis, jug-shaped, abcauline wall almost straight to weakly concave, slightly thickened, adcauline wall distinctly concave, floor asymmetrically curved, margin circular in anterior view, transverse to hydrothecal axis, rim slightly thickened.

One or two large nematothecae on basal stem internodes and one halfway along athecate cauline internode, base of nematotheca long and slender, cup large, adcaudally foreshortened; nematothecae on hydrocladial internode, base of median inferior short and stout, cup adcaudally foreshortened, not reaching hydrothecal floor, base of paired laterals long, without pedicel, cup smaller than others, not reaching hydrothecal margin.

Cnidome comprising microbasic euryteles all of same size, capsule elongate oval, 10 x 5 µm, shaft 7 µm long, spinous.

Colony transparent white, perisarc thin.

Remarks. It was originally considered that the species may be *Plumularia campanula* var. *geelongensis* Mulder and Trebilcock 1916, recorded by them only once from Corio Bay in Port Phillip. Careful search of the hydroid collections in Museum Victoria found no specimen of the variety *geelongensis* it is assumed that no specimens were ever lodged.

Their figure of var. *geelongensis* (p.76, pl. 11, figs 2, 2a–c) shows a deep cup-shaped, straight-sided hydrotheca, suggesting that the specimen may have been a variant of *Halopteris campanula* (Busk, 1852), a species common in Victorian oceanic habitat.

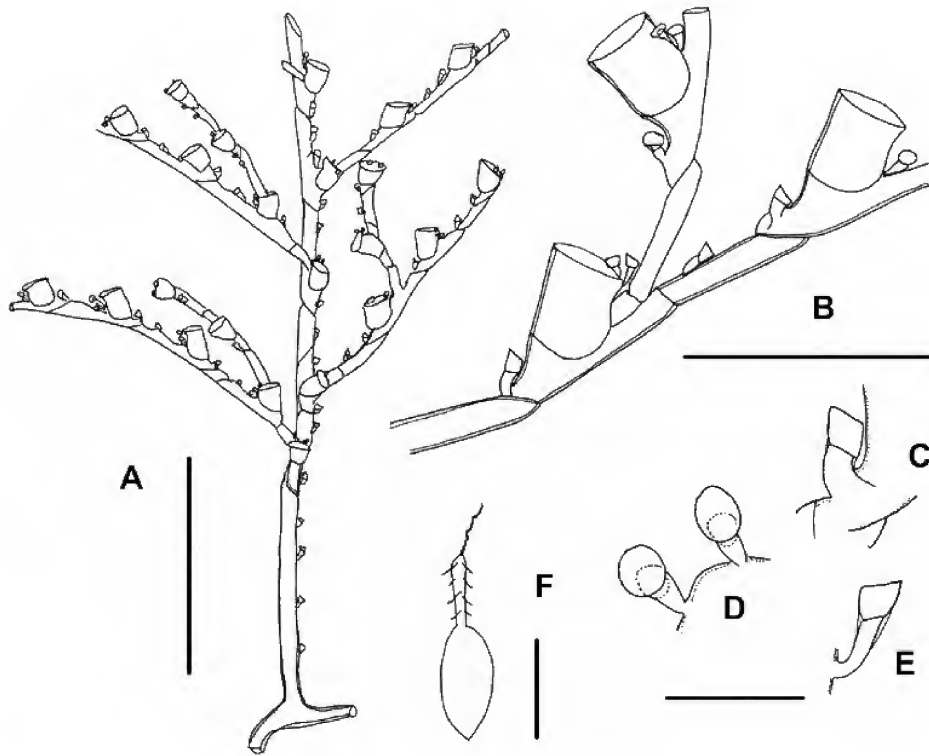


Figure 1A-F. *Halopteris urceolata* sp. nov. A, part of stem of holotype colony (NMV F207310) showing secondary branching. B, branched hydrocladium. C, median inferior nematotheca. D, twin lateral nematothecae. E, cauline nematotheca. F, microbasic eurytele. Scale bar: A, 1.0 mm; B, 0.3 mm; C-E, 0.1 mm; F, 10 μ m.

Table 1. Measurements (μ m) of *Halopteris urceolata*

Hydrorhiza, diameter of stolon	64-102
Stem internode	
length	576-696
width at node	100-108
Hydrocladium	
length of athecate internode	120-140
length of thecate internode	300-340
width at node	60-76
Hydrotheca	
length of adcauline wall	160-180
length of abcauline wall	112-120
diameter of margin	152-168
Nematotheca	
total length of cauline	176-200
total length of lateral	132-152

The secondary hydrocladial branching seen in *Halopteris urceolata* somewhat resembles that of *Schizotracha* (= *Halopteris*) *simplex* Warren, 1914 from South Africa. The paired basal branching present in some hydrocladia of *H. urceolata* sometimes also occurs in *Halopteris tenella* (Verrill, 1874) from the North Sea (see Schuchert (1997) and also occasionally in *H. campanula* from southern Australia (Watson unpubl.).

Schuchert (1997) mentioned difficulty in deciding whether the cnidome of *Halopteris campanula* comprises microbasic mastigophores or microbasic euryteles. As the present material of *Halopteris urceolata* was preserved prior to examination only a few partially discharged nematocysts were found; these suggest that the cnidome probably also comprises microbasic euryteles.

Ecology. The species occurs in sheltered habitat on jetty piles.

Etymology. Named for the jug-shaped hydrotheca.

***Plumularia rotunda* Mulder and Trebilcock, 1911**

Figure 2A–G

Plumularia delicatula var. *rotunda* Mulder and Trebilcock, 1911: 116, pl. 2, fig. 2.

Plumularia rotunda Bale, 1919: 343, pl. 17, fig. 1.– Stranks, 1993: 13.–Bouillon *et al.*, 2006: 370.

Material examined. NMV F57984, microslide, Museum Victoria Trebilcock collection, labelled “Type, *Plumularia delicatula* var. *rotunda* Bream Creek”; NMV F207643 microslide, malinol mounted, coll: J. Watson 15/04/2012, reef 21 m deep, 1.5 km off Barwon Heads, Victoria.

Description (from live, preserved and mounted material). Colony infertile, hydrorhiza a rugose stolon with internal flexion joints. Stems straight, monosiphonic, to 7 mm high, of same diameter throughout, basal one third to half of stems ahydrocladate with some transverse joints and cauline nematothecae, apophyses at sites of previously shed hydrocladia.

Stem internodes short, straight, expanding a little distally, nodes oblique to transverse, some a deep V-shaped joint, younger internodes without internal septa, older ones with several transverse intranodal septa.

Hydrocladia alternate, planar, given off at or near distal cauline internode, apophysis short, proximal node transverse or slightly oblique, distal node a broad transverse shoulder. Hydrocladium with one or usually two hydrothecae, proximal athecate internode short, expanding distally from apophysis, with one or two deep transverse internal septa and deep indentations in perisarc, occasionally athecate internode extended distally by several secondary nodes; if two or more hydrothecae present on hydrocladium, these separated by a long athecate internode with internal septa, often bearing a median nematotheca.

Hydrotheca occupying two thirds of internode, base of internode straight below hydrotheca; infrathecal hydrothecal chamber large, adcauline wall of hydrotheca entirely adnate to internode, convexly curved, abcauline wall strongly convex to rounded, a hook-shaped thickening passing down from abcauline wall to margin (lateral view), appearing as a submarginal septum in anterior view. Margin of hydrotheca facing obliquely backwards, sub-rectangular in anterior view, rim weakly lobate, in lateral view partly obscured by submarginal septum and abcauline wall. Hydranth with about 18 tentacles.

Nematothecae all of same size, base conical, cup quadrangular in outline, wall slightly adcaudally foreshortened, one about halfway along and closely adpressed to stem internode, one in axil of apophysis, one median behind infrathecal chamber, base slightly wider than others; twin laterals with slender base below hydrotheca, not reaching hydrothecal margin.

Cauline perisarc thick, stem pale brown at base fading to colourless or white below first hydrocladium.

Remarks. This redescription of *Plumularia rotunda* from fresh material augments the descriptions of Mulder and Trebilcock (1911) and Bale (1919).

Table 2. Measurements (μm) of *Plumularia rotunda*

Hydrorhiza, width	104–120
Stem internode	
length	280–332
width at node	56–100
Apophysis	
adcauline length	40–44
width at distal node	56–60
Hydrocladium	
length athecate internode	60–72
length thecate internode	240–260
Hydrotheca	
maximum depth	148–168
maximum length	160–220
width of margin	92–120
Nematotheca	
length of base	30–50
width of cup	30–36

The Trebilcock hydroid collection of Museum Victoria contains some fragmented, poorly labelled and several unlabelled microslide specimens of *Plumularia delicatula* var. *rotunda* Mulder and Trebilcock, 1911 those labeled being from the central Victorian coast. The authors considered it to be a variety of *P. delicatula* Bale, 1882 but their figure provides little morphological information. A microslide (NMV F57984) labelled “*Plumularia delicatula* var. *rotunda* Mulder and Trebilcock, 1911 Type”, is suggested a possible syntype by Stranks (1993) and I designate this microslide as lectotype of *Plumularia rotunda*. I also designate as paralectotypes of *Plumularia rotunda* Mulder and Trebilcock’s microslide NMV F222407, labelled “co-type” from Bream Creek; microslide NMV F222408 from Barwon Heads displaying two gonothecae, and microslide NMV F222409 from Bream Creek, labelled “abnormal growth”. I further designate as paralectotype of *Plumularia rotunda* a microslide (NMV F222406) in the Bale hydroid collection of Museum Victoria, labelled in Bale’s handwriting “*Plumularia delicatula* var. *rotunda*, Mr Mulder, 1907 Geelong”. Based on this microslide, Bale (1919) provided a more detailed description and better figures of the variety *rotunda*, raising it to specific rank.

Ecology. Although Mulder and Trebilcock left no traceable field notes about collection of specimens it is assumed that their specimens were from algae cast up on local ocean beaches. The underside of the common prostrate leathery red alga *Peysonnelia* from which the present fresh specimens were collected provides secure habitat for small cryptic hydroids.

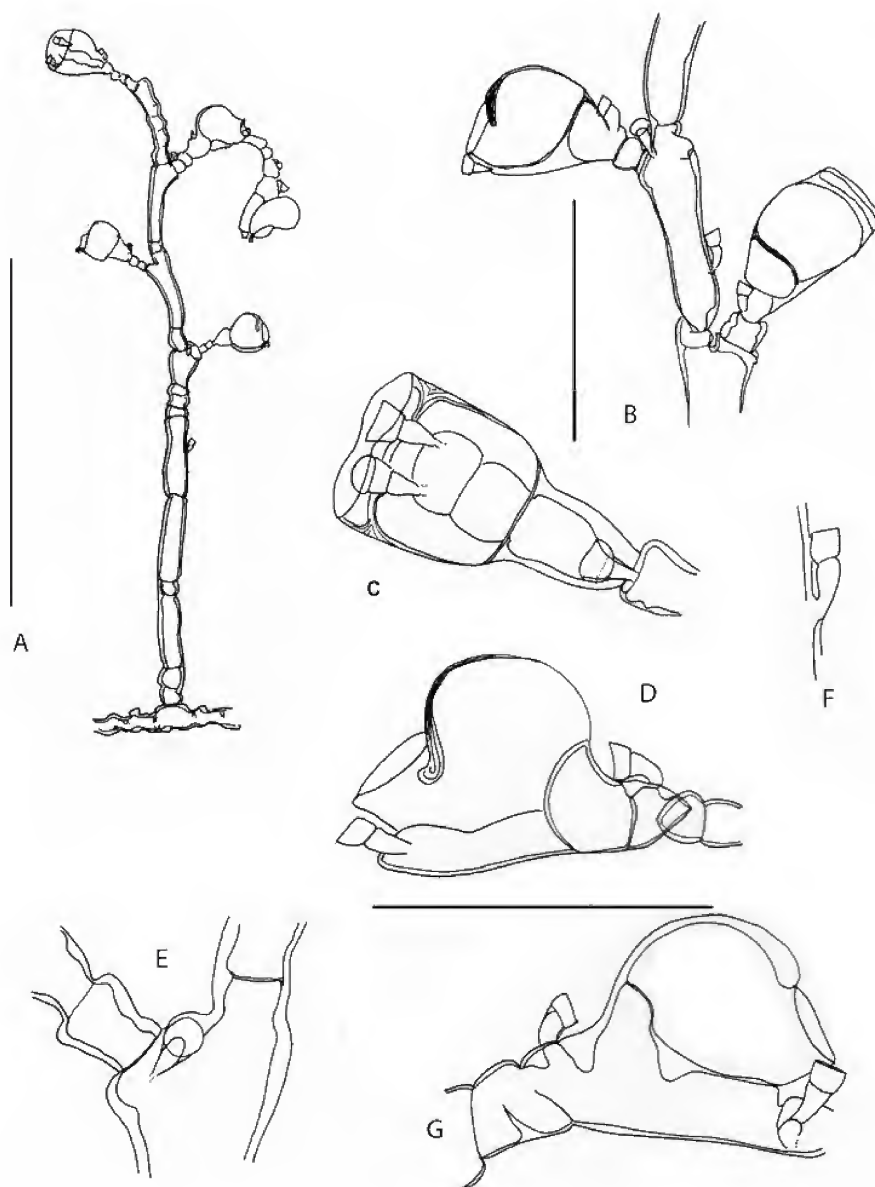


Figure 2 A-G. *Plumularia rotunda* (NMV F207643) from Barwon Heads. A, stem. B, stem internode and hydrothecae, C, hydrotheca, ventral view. D, hydrotheca, lateral view showing deep submarginal ridge. E, *Plumularia rotunda*, hydrotheca of (NMV F57984) lectotype of *Plumularia delicatula* var. *rotunda* Mulder and Trebilcock, 1911 for comparison with D. F cauline internode, and axillar nematotheca of (NMV F207643). G, cauline nematotheca of (NMV F207643). Scale bar: A, 1.0 mm; B, 0.5 mm; C-G, 0.2 mm.

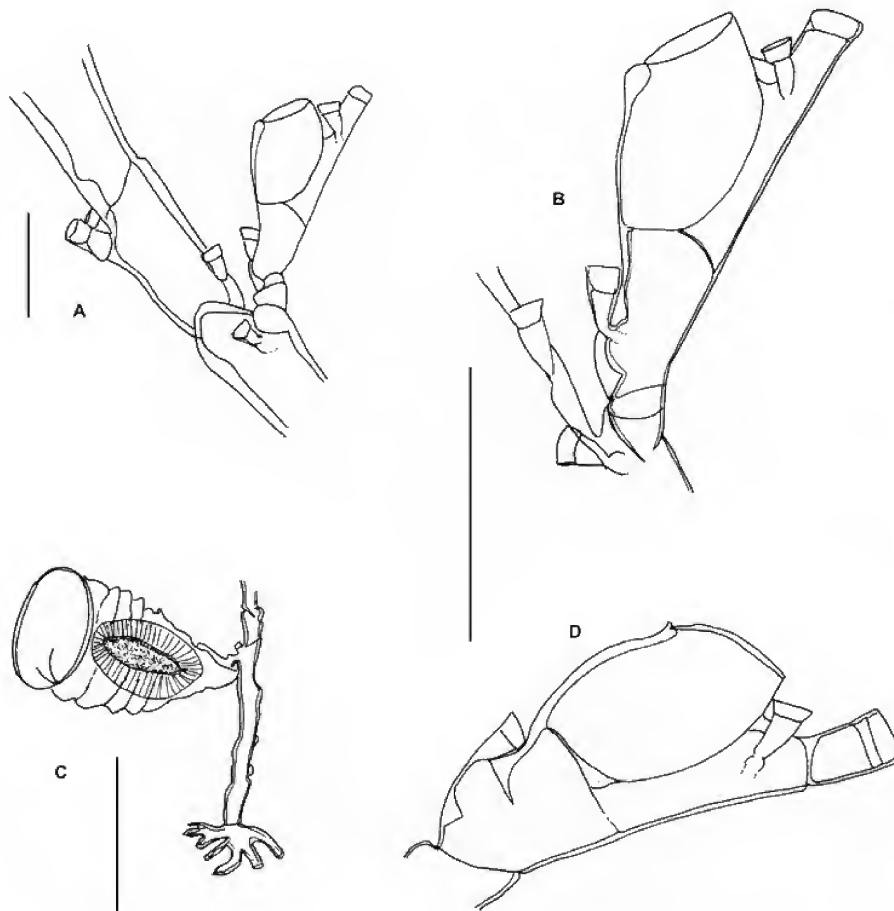


Figure 3 A-D. *Plumularia wilsoni*. (A-C, from Robe, South Australia, author's collection). A, stem internodes with hydrotheca. B, hydrocladium and hydrotheca. C, male gonotheca. D, hydrotheca of lectotype (NMV F59050). Scale bar: A, B, D, 0.2 mm; C, 1.0 mm.

Note on *Plumularia wilsoni* Bale, 1926

Figure 3A-D

A microslide NMV F59050 in the Bale collection of Museum Victoria displays two infertile stems labelled “*Plumularia delicatula* Bale, 1882, Griffiths Point, 1881, J.R.Y. Goldstein”. Stranks (1993) suggested it may be a syntype of *P. delicatula*. I designate this microslide as lectotype of *Plumularia delicatula* Bale, 1882. Bale (1882, 1919) provided good descriptions of *P. delicatula* but because of pre-occupation of the name [now

Lytocarpia delicatula (Busk, 1852)] in 1926 he renamed the species *Plumularia wilsoni*.

Plumularia wilsoni has since been recorded from New Zealand (Ralph 1961) and Tasmania (Watson 1975). Vervoort and Watson (2003) suggested that *Plumularia wilsoni* may be an extreme variant of *Plumularia setaceoides* Bale, 1882, however, comparison of the lectotype of *P. delicatula* with material from Tasmania and South Australia (author, unpubl.) shows constant morphological features that clearly distinguishes *P. wilsoni* from *P. setaceoides*.

Acknowledgements

I thank Geoff Pearce and Andrew Newton for diving companionship and assistance in collecting specimens.

References.

- Bale, W.M. 1882. On the Hydroida of south-eastern Australia, with descriptions of supposed new species, and notes on the genus *Aglaophenia*. *Journal of the Microscopical Society of Victoria* 2: 3–36, pls 12–15.
- Bale, W. M. 1884. *Catalogue of the Australian Hydroid Zoophytes*. Australian Museum Sydney. Pp. 198, pls 1–19.
- Bale, W.M. 1919. Further notes on Australian hydroids – IV. *Royal Society of Victoria* 31(2): 119–361, pls 16–17.
- Bouillon, J., Gravili, C., Pagès, F., Gili, J.-M. and Boero F. 2006. *An Introduction to Hydrozoa*. Publications Scientifiques du Muséum Paris. 591 pp.
- Millard, N.A.H. 1975. Monograph on the Hydroida of southern Africa. *Annals of the South African Museum* 68: 1–513.
- Mulder, J.F. and Trebilcock, R.E. 1911. Notes on Victorian hydroids with descriptions of new species. *Geelong Naturalist* 4(2): 115–120, pls 2, 3.
- Mulder, J.F. and Trebilcock, R.E. 1914b. Victorian Hydroida with description of new species. *Geelong Naturalist* 6(2): 38, pls 4–6.
- Mulder, J.F. and Trebilcock, R.E. 1916. Notes on Victorian Hydroida. Part VI. *Geelong Naturalist*, 6: 73–84.
- Ralph, P.M. 1961. New Zealand thecate hydroids. Part IV. The family Plumulariidae. *Transactions of the Royal Society of New Zealand, Zoology* 1: 19–74.
- Schuchert, P. 1997. Review of the family Halopterididae (Hydrozoa, Cnidaria). *Zoologische Verhandelingen, Leiden* 309: 1–162.
- Stranks, T.N. 1993. Catalogue of recent Cnidaria type specimens in the Museum of Victoria. *Occasional Papers of the Museum of Victoria* 6: 1–26.
- Verrill, A.E. 1874. Report upon the invertebrate animals of Vineyard Sound and the adjacent waters, with an account of the physical characters of the region. *United States Commission of Fish and Fisheries 1871-1872*: 295–778.
- Vervoort, W. and Watson, J.E. 2003. Marine Fauna of New Zealand. Leptothecata (Cnidaria: Hydrozoa) (Thecate Hydroids) *NIWA Biodiversity Memoir* 119: 1–538.
- Warren, E. 1914. On the development of the planula in certain species of Plumularian hydroids. *Annals of the Natal Museum* 3: 83–102.
- Watson, J.E. 1975. Hydroids of Bruny Island, southern Tasmania. *Transactions of the Royal Society of South Australia* 99: 157–176.

Enigmatic ophiuroids from the New Caledonian region

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Abstract

O'Hara, T.D. and Harding, C. 2015. Enigmatic ophiuroids from the New Caledonian region. *Memoirs of Museum Victoria* 73: 47–57.

Three new species are described from New Caledonia which have been provisionally placed in the genera *Ophiohamus* (Ophiacanthidae), *Ophionereis* (Ophionereididae) and *Ophiodaphne* (Amphiuridae) respectively, pending a comprehensive revision of the Ophiuroidea. In addition, new specimens and morphological variation is described for the species *Amphipholis linopneusti* (Amphiuridae). Our knowledge of the deep-sea fauna of New Caledonia remains incomplete.

Keywords

Brittle-stars, marine, continental slope, Pacific Ocean, *Ophiohamus*, *Ophionereis*, *Ophiodaphne*, *Amphipholis*.

Introduction

Our knowledge about deep-sea biodiversity is inadequate. Expeditions to even well-sampled regions continually turn up new species; many of which challenge our preconceived notions about the evolution of marine animals and their established taxonomy. One of the best sampled regions at bathyal depths is the New Caledonian Exclusive Economic Zone (EEZ). For the past 40 years, the Museum National d'Histoire Naturelle of Paris (MNHN) and the Institut de Recherche pour le Développement (IRD) have explored the diversity of the deep-sea benthos of the New Caledonian EEZ through the Tropical Deep-Sea Benthos program (TDSB). In all there have been 37 expeditions collecting approximately 3,800 samples, largely from the continental shelf and upper bathyal (200–1000 m) zones (S. Samadi *pers. comm.*).

This paper reports on four species from New Caledonia that stretch the limits of the existing generic classification of the Ophiuroidea (brittle-stars). Three are new species with clearly defined diagnostic characters; the fourth appears to be part of a morphological complex that possibly contains cryptic species. New comprehensive genetic data has shown that the existing classification of ophiuroids is flawed, from genus to order level (O'Hara et al. 2014, Hugall et al. 2015). Many morphological characters traditionally used to define genera and families have evolved multiple times. To date, only microscopic skeletal characters such as arm spine articulations have been successfully used to define higher-level taxa (Martynov 2010; Thuy & Stöhr 2011; O'Hara et al. 2014). A new classification of the Ophiuroidea is required.

The type material of the new species was dried after preservation. Given the fragile and rare nature of these

specimens we have not attempted dissection or SEM photography and the species descriptions are only of external features. The images were taken with a Visionary Digital Integrated System, using a Canon 5D Mark II camera with EF100mm and MP-E65mm macro-lenses, and montaged using Zerene Stacker v1.04 software.

Abbreviations include d.d. – disc diameter; stn – station; MNHN – Museum National d'Histoire Naturelle; MV – Museum Victoria; AM – Australian Museum; UF – Florida Natural History Museum.

Systematic Account

Family Ophiacanthidae

Ophiohamus georgemartini sp. nov.

Fig. 1

Zoobank LSID. <http://zoobank.org/urn:lsid:zoobank.org:act:11DC6E76-463D-42BE-AD04-25622254FB64>

Type material. – New Caledonia. SMIB5: stn DW94, Banc Alis, 22° 19.6'S, 168° 42.8'E, 275 m, 10 Sept 1989, holotype: 1 (MNHN IE.2013.16001).

Description. Disc 3.8 mm diameter, arms (all broken at tip) at least 10 times d.d., curved but not coiled. Disc circular, without interradiial incisions, dominated by 5 pairs of large triangular radial shields, with rounded angles, 0.35 times d.d., contiguous for most of their length radially, separated at the distal and proximal ends by small scales, the former a small triangular

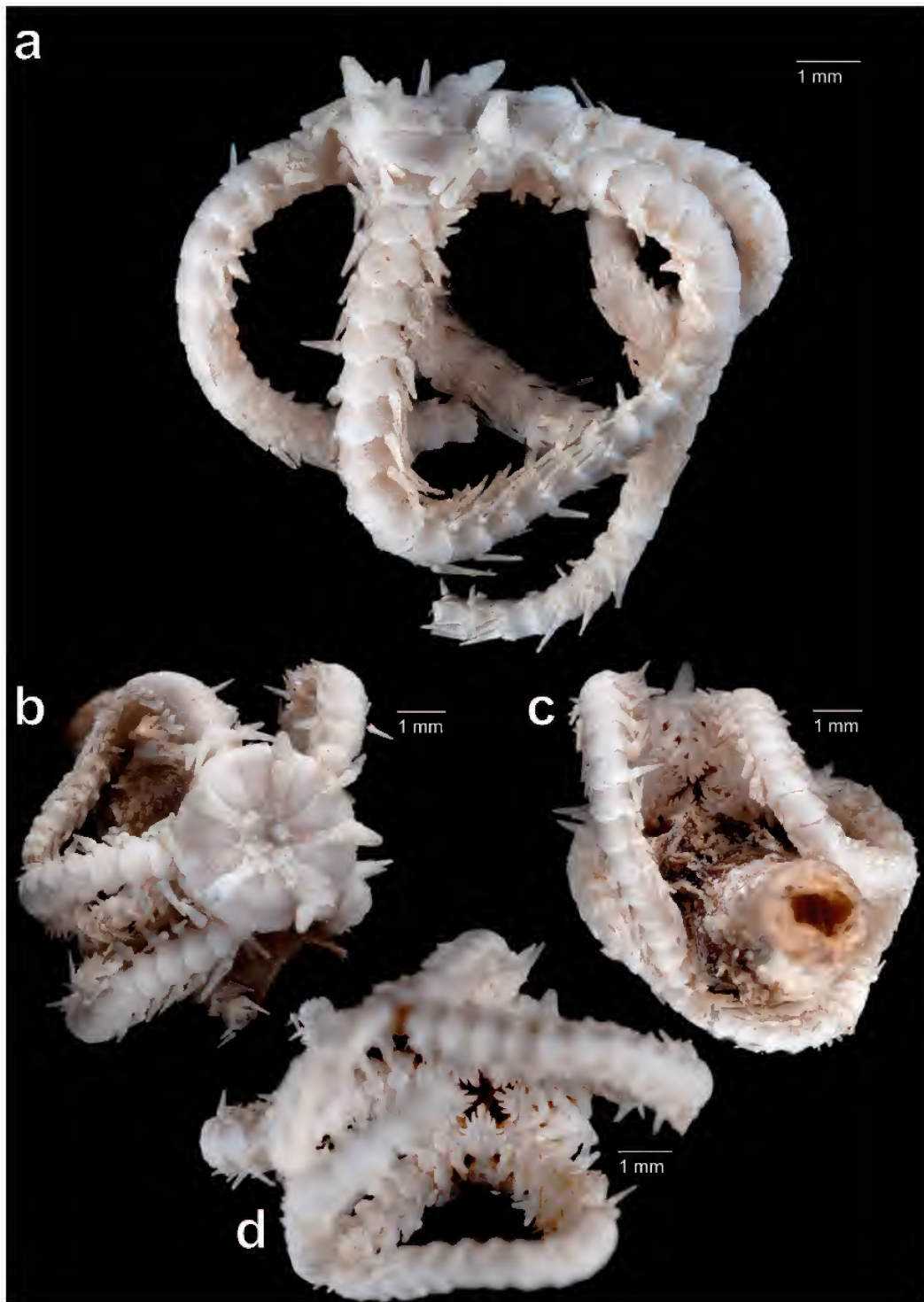


Figure 1. *Ophiohamus georgemartini* sp. nov., holotype MNHN IE.2013.16001, A, lateral view; B, dorsal view; C, ventral view; D ventral view (with glass sponge removed).

plate, possibly homologous to the dorsal arm plates. One row of 3–4 polygonal interradial plates separate the radial shields and a cluster of irregular rounded overlapping disc scales centrally. A large conical spine is present on the distalmost plate of each interradius, 0.7 mm high and 0.5 mm in diameter at the base. On one interradius, there is a second conical spine on the next proximal interradial plate, on another interradius there are two small round granules, 0.14 mm diameter; 1–2 similar granules are also present on some central plates.

Ventral disc covered in several rows of polygonal or rounded overlapping scales. Wide genital slits. Oral shields diamond shaped, two times as wide as long. Adoral shields thick, sausage-shaped, proximal to oral shields, contiguous interradially, twice as wide as long, extending beyond the lateral angles of the oral shields, beaded surface. Apical papilla conical, twice as high as wide; three slender subequal oral papillae borne on the oral shields, the distal papilla abutting the adoral shield and overlying the second oral tentacle pore.

Dorsal arm plates rounded triangular, with straight lateral edges and slightly convex distal edge, first two plates just contiguous, others separated widely by the lateral arm plates. First ventral arm plate small, projecting into jaw space, contiguous with the second plate. Succeeding ventral arm plates pentagonal at first, but from segment three becoming more rectangular or rounded, separate, without a proximal angle, longer than wide, lateral sides incurved to accommodate the pore, distal edge convex to truncate. Lateral arm plates with striated surface for much of the arm, with a large distal flange bearing up to four arm spines. Separated ventrally by a small uncalcified area basally. Basal arm spines conical with a blunt tip, three times as high as the basal diameter, 1.3 segments long, middle spines flattened and covered in minute thorns, restricted to the lateral side of the arm after the first two segments. Four arm spines persist to (near) arm tip, becoming slender and pointed, uppermost spine exceeding a segment in length, lowest half that length, becoming hooked (curved and rugose on the proximal side). Arm spine articulation, rounded volute-shape. A single oval tentacle scale covers the small tentacle pore, as long as one third of the ventral arm plate.

Colour (dry): white. Arms originally curved around a small hollow glass sponge.

Distribution. New Caledonia (275 m)

Remarks. The volute-shaped arm spine articulation surface and overall appearance indicates that this species is an Ophiacanthidae (Martynov 2010). Within this family, the new species is closest to the genera *Ophiomitrella* and *Ophihamus*, having relatively large disc scales and radial shields, the former often bearing spines/granules, but lacking the deep interradial disc incisions characteristic of *Ophioplinthaca* or the enlarged ventral interradial disc scale characteristic of *Ophiurothamnus*. The new species bears a strong resemblance to *Ophihamus nanus* O'Hara & Stöhr, 2006 in the shape of the disc plates, radial shields, arm plates and arm spines, adoral and oral shields. But *O. nanus* differs in having no disc spines or

granules; relatively small radial shields, 1/4 d.d.; several rows of disc scales interradially; only two oral papillae on most jaw sides, the outer being widened; and only three arm spines distally. The new species lacks the interradial incision present on the holotype of *O. nanus* but this was not consistently present on the paratypes. Some species of *Ophiomitrella* and *Ophiurothamnus* have large disc spines or tubercles, either cylindrical (*Ophiomitrella nugator* (Koehler, 1922a), *Ophiurothamnus excavatus* Koehler, 1922a) or capitate (*Ophiomitrella conferta* (Koehler, 1922b)) but they are never as robust and conical as the marginal spines in the new species.

The genus-level classification of the Ophiacanthidae is inadequate (O'Hara & Stöhr 2006), with the large genera *Ophiacantha* and *Ophiomitrella* being polyphyletic (O'Hara & Hugall unpublished genetic data). Until a new classification is proposed, we place the new species in *Ophihamus*. However, this requires an amendment of the generic diagnosis to accommodate a species with no interradial disc incision, as follows: Disc covered with coarse overlapping disc plates and large contiguous radial shields that are integrated into the disc plating, spines may be present, a shallow interradial incision in disc margin may be present, 2–3 spiniform oral papillae, with a widened outer papillae replacing the distal two, small oral and adoral shields, oral shields contiguous with the lateral arm plate and lying distal to the adoral shields, oral tentacles enclosed within jaw slit. Arms can curve ventrally but don't coil, small mostly separate dorsal and ventral arm plates, 3–4 arm spines restricted to the lateral side of the arm, relatively short, up to, or just exceeding, a segment in length, lowest spine semi-hooked, small tentacle pore covered by a simple tentacle scale.

Etymology. Named after the author, George R.R. Martin, because the large marginal disc spines of the new species look similar to the crown on the cover of his second book in the 'Games of Thrones' series, 'A Clash of Kings'.

Family Ophionereididae

Ophionereis sykesi sp nov

Fig. 2

Zoobank LSID. <http://zoobank.org/urn:lsid:zoobank.org:act:F6388E19-397A-482A-90A8-1DA7BE551083>

Type material. -- *New Caledonia*. BIOCAL: stn CP110, Ride de Norfolk, 22° 12.38'S, 167° 6.43'E, 275–320 m, 9 Sept 1985, holotype (MNHN IE.2013.16002); paratypes, same locality: 26 (MNHN IE.2013.16003).

Other material examined. -- *New Caledonia*. -- Bathus 1: stn DW688, Côte est, 20° 33.17'S, 165° 0.37'E, 270–282 m, 1993: 14 (MNHN IE.2013.6536). -- Bathus 2: stn DW716, Sud-ouest, 22° 40.81'S, 167° 12.07'E, 290–308 m, 1993: 1 (MNHN IE.2013.6541). -- Bathus 2: stn DW717, Sud-ouest, 22° 44.02'S, 167° 16.58'E, 350–393 m, 1993: 1 (MNHN IE.2013.6542). -- EBISCO: stn DW2559, NW Bellona, 20° 28'S, 158° 41'E, 255–280 m, 2005: 1 (MNHN IE.2007.5401). -- EBISCO: stn CP2592, Plateau des Chesterfield, 19° 42'S, 158° 30'E, 273–281 m, 2005: 1 (MNHN IE.2007.5174). Musorstom 6: stn DW399, Ride des Loyauté, 20° 41.8'S, 167° 0.2'E, 282 m, 1989: 1 (MNHN IE.2013.6537). -- Musorstom 6: stn DW418,

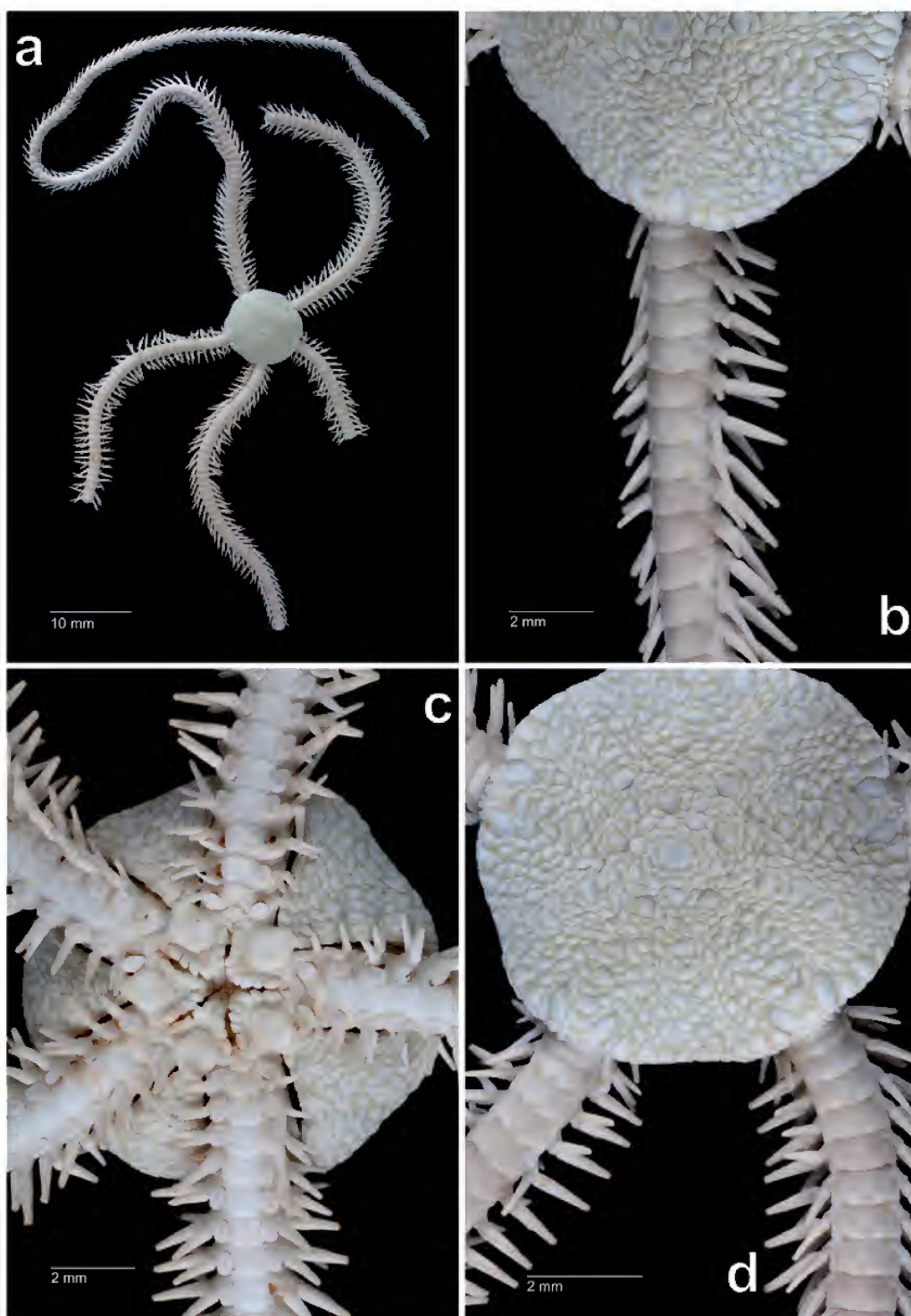


Figure 2. *Ophionereis sykesi* sp. nov., holotype MNHN IE.2013.16002, A, dorsal view of whole animal; B, oblique view of arm showing the supplementary dorsal arm plates dorsal view of disc and arm base; C, ventral view of disc and arm bases; D, dorsal view of disc and arm base.

Ride des Loyauté, 20° 41.75'S, 167° 3.35'E, 283 m, 1989: 1 (MNHN IE.2013.6538). -- Musorstom 6: stn DW422, Ride des Loyauté, 20° 26.2'S, 166° 40.31'E, 257 m, 1989: 1 (MNHN IE.2013.6539). -- Musorstom 6: stn DW423, Ride des Loyauté, 20° 25.85'S, 166° 40.5'E, 280 m, 1989: 9 (MNHN IE.2013.6540). -- SMIB5: stn DW95, 22° 59.7'S, 168° 19.8'E, 140–200 m, 1989: 1 (MNHN IE.2013.6544). -- SMIB5: stn DW96, 23° 0'S, 168° 18.7'E, 245 m, 1989: 1 (MNHN IE.2013.6545). -- **Vanuatu**. GEMINI: stn DW50, Mont Gemini, 20° 59.1'S, 170° 3.5'E, 425 m, 1989: 1 (MNHN IE.2013.6543).

Comparative Material. *Ophionereis degeneri* (A.H. Clark, 1949): FFS-0021, French Frigate Shoals, 23° 51.792'N, 166° 11.052'W, 85 m, 12/10/2006, UF 6679. FFS-0026, French Frigate Shoals, 23° 51.702'N, 166° 11.112'W, 12 m, 12/10/2006, UF 6039. *Ophionereis variegata* Duncan, 1879: BIOLUM/21, Lizard Is, Big Vicki, 14° 41.4'S, 145° 26.2'E, 2–4 m, 26/10/2005, MV F109863 (3). BIOLUM/30, Lizard Is, 7–14 m, 26/10/2005, MV F109864 (1). CReefs/GD.HI08–10, Heron Island, south side, 23° 28.4'S, 151° 57.83'E, 18 m, 6/9/2008, MV F211039 (4). HI09–011, Heron Island, Pinnacle, 23° 28.333'S, 151° 57.028'E, 9–10 m, 13/11/2009, UF 9963. HI09–018, Heron Island, Sykes Reef, 23° 25.943'S, 152° 2.025'E, 30 m, 14/11/2009, UF 9988. HI09–098, Heron Island, 23° 27.193'S, 151° 54.027'E, 24–26 m, 24/11/2009, UF 10115.

Description. Disc round, 10.4 mm diameter, arms at least 12 times d.d. (arm tips all broken). Disc covered in rounded overlapping scales, up to 0.35 mm diameter, primaries evident but small, centrodorsal 0.4 mm diameter, approximately 18 plates between centrodorsal and interradial margin, marginal plates slightly larger than adjacent ones, forming a rim to the disc. Radial shields 1.0 mm long, twice as long as wide, roughly oval or triangular, with a truncate distal margin, convex lateral sides and an acute to rounded proximal angle, separated radially by 3 series of plates, the middle ones flanked by a row of smaller plates on either side. An irregular series of small papillae are present along the disc margin over the arm base, papillae conical with a blunt tip.

Ventral disc covered in similar overlapping plates as the dorsal surface, approximately 13 plates between oral shields and margin. Genital slits bordered interradially by an irregular series of rounded granules, obvious near the oral shield, becoming cuboid and contiguous from mid-radius to the disc margin (and often hidden within the slit), confluent with the papillae over the dorsal arm base. Oral shields rhomboid, just longer than wide, with rounded angles, and slightly concave sides. Adoral shields long and slender, tapering to a point proximally, rounded and widest distally, not contiguous with neighbouring plates, oral plates visible towards the jaw tip. Five oral papillae, inner papillae longest and orientated proximally so that they appear like infradental papillae on amphiuroids; next two papillae rhomboid to rectangular with flattened edge facing the jaw slit, fourth papillae 1.5 times as wide as high, rounded distally, touching the adoral shield, and finally a small recurved papilla at the end of the slit, sitting at the junction of the adoral plate and first ventral arm plate, protecting the second oral tube foot. Five teeth, dorsal three largest with thick enamelled tips, ventral one sits above the inner oral papillae.

Dorsal arm plates 0.75 mm wide, 1.8 times as wide as long, broadly contiguous throughout arm, hexagonal with a straight distal edge, straight distolateral sides that are contiguous with the supplementary arm plate, straight proximolateral sides

contiguous with the lateral arm plate, proximal edge overlaid by preceding plate. Basal supplementary dorsal arm plates small, roughly triangular, widest distally, extending proximally to the angle between the disto- and proximo-lateral sides of the dorsal arm plates, mostly lateral in position on the arm, appearing narrow and droplet-shaped from a dorsal projection. Dorsal arm plates become progressively more triangular in shape as the distolateral sides shorten and the proximolateral sides lengthen. Near the arm tip the distal side becomes convex and the proximolateral sides converge so that succeeding plates are only contiguous for 1/3 of their width. The supplementary plate becomes progressively smaller but persists as a tiny plate to (near) the arm tip. No accessory lateral arm plates, instead there is a decalcified gap between neighbouring lateral arm plates, the supplementary dorsal arm plate and the tentacle pore. First ventral arm plate diamond shaped, wider than long, the proximal sides contiguous with the adoral shields and distal oral papillae, the distal angle overlaps the second arm plate. Succeeding plates roughly quadrangular, as wide as long, with convex distal and proximal sides and concave lateral sides that border the tentacle pore, contiguous for 2/3 of their width. Second ventral arm plate with conspicuously convex distal edge. Plates becoming longer than wide near the arm tip, with convergent proximolateral sides, plates here contiguous for only 1/3 of their length.

Two arm spines on basal two segments, thereafter 3, slightly flattened to rounded, straight or slightly curved, blunt apex, on the first free segments the uppermost arm spine is 1.35 mm long, middle 1.5 mm long (to 1.7 segments long) and lowest 1.3 mm long. All 3 spines persist to the arm tip, slender, subequal to 1.2 segments in length. One thick ovoid tentacle scale, to 3/4 of a segment long, hinged on the ventral arm plate; a smaller rim-like scale on the ventral plate, usually overlain by the larger one. The ovoid scale persists to the arm tip.

Colour (dried). White with brown markings, notable on the proximal edge of large disc scales and around the interradial rim of the radial shields. Dorsal arm plates with dark patch at the centre of the distal edge, with white markings on either side. Arm spines with faint brown bands near the base and around the tip, brown markings around the periphery of the oral shields and on some basal ventral arm plates.

Paratype variations. From 4 to 10 mm dd. Some dorsal arm plates are darker in colour, forming narrow bands of 1–2 segments on the arms, alternating with bands of 3–5 lighter segments.

Distribution. New Caledonia (140–393 m), Vanuatu (425 m).

Remarks. The new species is very similar in overall appearance to *Ophionereis novaezelandiae* Mortensen, 1936 known from the outer shelf and upper slope of southern Australia (formerly as *O. terba* Baker & Devaney, 1981) and the north-eastern coast of New Zealand to the Kermadec Islands (O'Hara 1998, Mills & O'Hara 2013). This species differs however, in lacking the papillae around the dorsal arm base, slightly narrower dorsal arm plates (generally less than 1.7 times as wide as long), and arms that form tight horizontal coils (see Mills & O'Hara 2013, fig. 13b). The colour scheme is also brighter on *O.*

novaezelandiae; the two white patches on either side of the distal midline of the dorsal arm plates are rimmed by a darker colour forming characteristic 'm' shaped markings. The differences between these species are slight but consistent. The dorsal papillae are always present on specimens of the new species, including small specimens of only 5 mm d.d..

Both *Ophionereis fusca* Brock, 1888 and *O. sasakii* A.M. Clark, 1953 have some genital papillae that extend around the arms until the dorsal surface. However, the papillae are restricted to the dorsolateral sides of the arm and are discontinuous radially, i.e. not present distal to the area between the radial shields. While the genital papillae on *O. fusca* are contiguous and blunt, like *O. sykesi*, they are separate, spiniform and pointed on *O. sasakii*. *Ophionereis fusca* is covered in prominent dots (see A.M. Clark 1953, fig. 5) and *O. sasakii* has thick bands of colour on the arms, the dark and light sections being both approximately 6 segments long. Dorsal papillae or spines are also characteristic of the genus *Ophiodoris*, however, the species in that genus do not have any supplementary arm plates.

There are specimens of another diminutive *Ophionereis* from northern Australia, with similarly patterned dorsal arm plates to *O. novaezelandiae*, which has been assigned by Rowe & Gates (1995) to the Korean species *O. variegata* Duncan, 1879. The dorsal arm plates of these specimens have a dark spot in the middle of the distal rim, surrounded by a 'V'-shaped patch of white, which in turn is bordered by two dark longitudinal lines. The arms are also banded, with 2 (rarely to 4) dark segments to every light segment. These specimens have been generally found from 5 to 100 m depth, often living in the small holes of dead coral pieces, and only observed by scuba divers at night (O'Hara, personal observations). *Ophionereis variegata* (including the Australian specimens) differs from other species in having small accessory lateral arm plates, wedged between the supplementary dorsal arm plate and the tentacle scale. It is unclear whether the Australian specimens are really conspecific with *O. variegata* as the arm length appears to be considerably longer (to eight times d.d.) than the four to five times disc diameter reported from Korea (Duncan 1879), Japan (Matsumoto 1917 as *O. porrecta*) and China (Liao & Clark 1995). Another similar species, *O. lineata* H.L. Clark, 1946, has been described from the southern Great Barrier Reef. We have seen unpublished photos of this species from the Great Barrier Reef Seabed Biodiversity Project (Pitcher et al. 2007) which confirm the type specimen's distinct colour pattern (figured by Clark & Rowe 1971 and Baker & Devaney 1981), having three to five light segments alternating with one to two darker ones, and a dark longitudinal line running down the centre of the dorsal arm surface bordered by two lighter lines, in turn bordered (on the lighter segments) by a dense pattern of small dots. Ventrally there are two faint longitudinal dark lines or series of dots. Two other species that can have two prominent white dots on each dorsal arm plate, *O. olivacea* H.L. Clark, 1901 and *O. squamulosa* Koehler, 1913 from the Caribbean (see Hendler 1995 fig. 51), may also be related. Finally, *O. degeneri* A.H. Clark, 1949 described from Hawaii, with similar specimens reported from New Caledonia (Stöhr 2011), differs from the other species in

having small circular disc scales and no prominent primary plates (see Stöhr 2011 fig. 15). Moreover, specimens from Hawaii (UF) do not have white markings on the dorsal arm plates. Thus, in conclusion, the Australian specimens of '*O. variegata*' possibly represent a new species, but this requires confirmation from a thorough morphological or molecular comparison with northern Pacific populations. None of these species have the marginal disc papillae running over the dorsal arm base that are found in *O. sykesi*.

A new genus-level revision of the Ophionereidae/Ophiichitonidae is required. The ophiuroid phylogenies of O'Hara et al. (2014) and Hugall et al. (2015) show that the Ophiichitonidae is paraphyletic with respect to the Ophionereidae. There is a morphological transition from *Ophiichiton*, *Ophioplax* and *Ophiodoris* with no supplementary dorsal arm plates, through *Ophionereis australis* (H.L. Clark, 1923) where they are restricted to a few basal segments, to *O. novaezelandiae* with small supplementary plates that persist down the arm, and finally to *O. annulata* (Le Conte, 1851) and *O. schayeri* (Müller & Troschel, 1844) where there are large persistent supplementary arm plates. The new species is assigned provisionally to *Ophionereis sensu lato* but we anticipate a future revision that recognises a clade including at least this species, *O. novaezelandiae*, *O. variegata*, *O. lineata* and *O. degeneri* at the genus or subgenus level of classification.

Etymology. Named after the wife of TOH, Deborah Sykes, who has had to put up with him rummaging around the world's museum collections for years.

Family Amphiuridae

Ophiodaphne impellera sp nov

Fig. 3

Zoobank LSID. <http://zoobank.org/urn:lsid:zoobank.org:act:4F1FE97F-6B95-40AE-BDA1-092DED147E52>

Type material. -- New Caledonia. BIOCAL: stn CP23, Sud ouest, 22° 45.8'S, 166° 20.33'E, 2040 m, 28 Aug 1985, holotype (MNHN IE.2013.16004). -- paratype, same locality (MNHN IE.2013.16005)

Description. Disc 5.5 mm diameter, rounded pentagonal in outline; arms emerging from underneath the disc, at least 2.5 times d.d. (all broken). Disc completely covered in rugose scales. Radial shields 0.31 times d.d., D-shaped to pentagonal, with an acute proximal angle, straight to slightly convex adradial margin, convex abradial margin, and rounded distal edge, contiguous for distal half of length but separated proximally by 2 small disc plates, rugose surface. The centre of the disc is dominated by the primary plates with small intercalary plates at their corners, primary plates with thickened borders and tuberculate centre. Interradius with several overlapping plates, one or two plates wide proximally, then becoming more numerous near the margin, large plates with thickened distal edge, smaller marginal plates particularly rugose. A row of small plates border the radial shields distally over the arm. Ventral surface covered in thin flat, circular scales, persisting to oral shields.

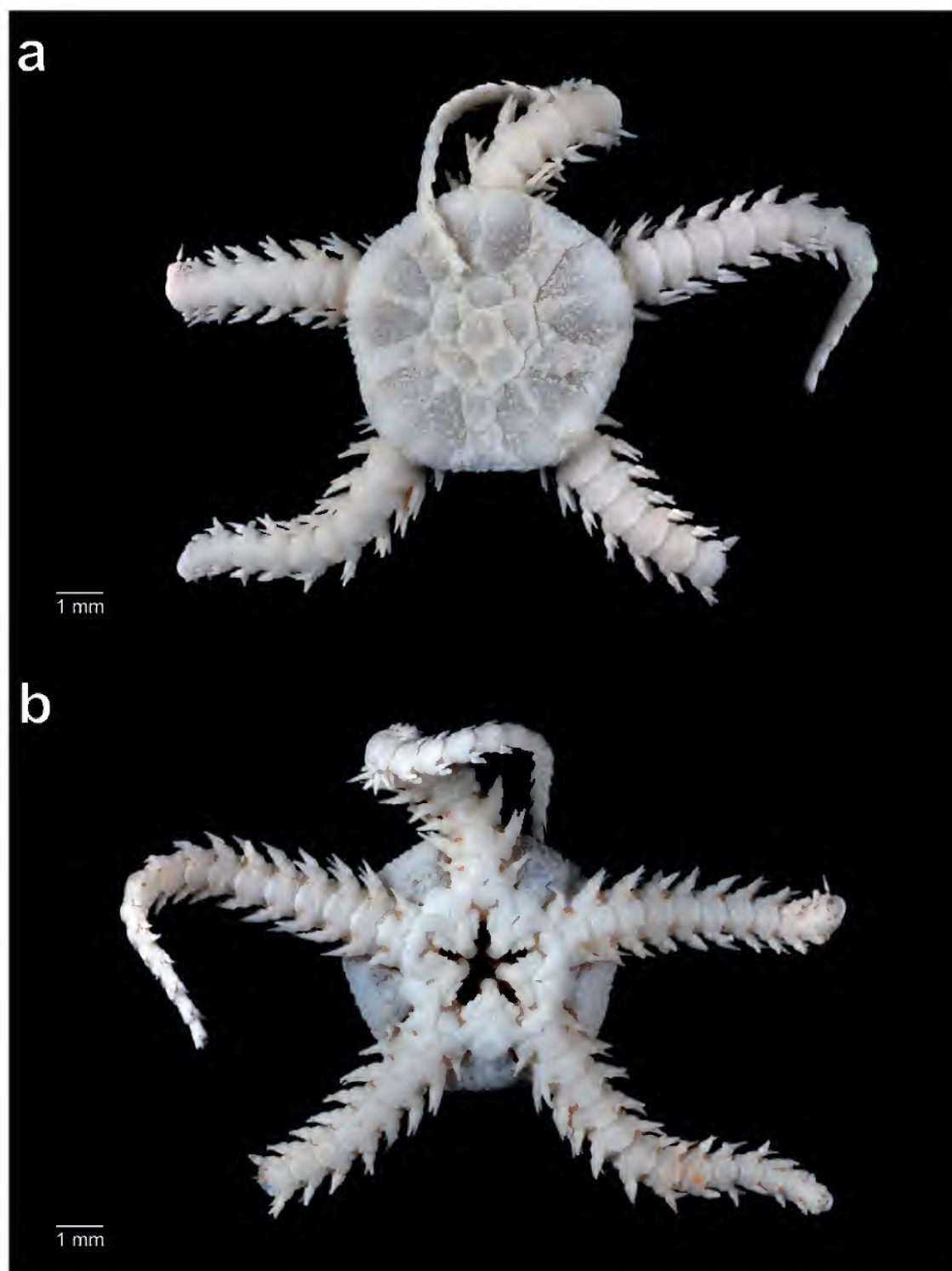


Figure 3. *Ophiodaphne impellera* sp. nov., holotype MNHN IE.2013.16004, A, dorsal view, B, ventral view.

A pair of pointed papillae at each jaw apex; 3-4 oral papillae on each jaw side, the proximal one wide and rim-like, pointed proximally (probably the first oral tentacle or buccal scale); the next 2 papillae squarish with rounded corners, the outer of the 2 slightly larger, sometimes a tiny scale is present either distally at the interstice of the oral and first ventral arm plate, protecting the second oral tentacle pore, or between the first and second oral papillae. Ventral surface of the oral plates triangular in shape, meeting broadly within, beaded surface, the pair of oral plates forming a wide obtuse shaped jaw. Teeth twice as wide as long with a broad enamelled margin. Oral shields roughly diamond-shaped, wide as long, with an obtuse proximal angle and rounded to lobed distal margin, acute lateral angles. Madreporite twice as large as other shields. Adoral shields tumid, wider than oral shield, trapezoid, widest radially, broadly contiguous interradially. Bursal slit extends to near disc margin, genital plates obscured.

Dorsal arm plates twice as wide as long, with an obtuse proximal angle, convex distal margin and rounded lateral angles, always separate, distal section of the plate with slightly tuberculate surface. Lateral arm plates beaded, meeting above and below arm, except basally where there is a small decalcified area between the ventral arm plates. Arm spine articulation formed from 2 parallel ridges, orientated radially. First ventral arm plate rounded triangular with a curved distal and obtuse proximal angle, forming distal margin to relatively wide oral cavity between jaws. Second to fourth plates twice as long as wide, roughly pentagonal with a straight to slightly convex distal edge, rounded distolateral angles, straight sides and convergent proximal edges that form an obtuse angle on the midline. The mid of the distal edge and the obtuse proximal angle can be produced into a small lobe that partially fills the decalcified area. Plates becoming progressively more triangular as the lateral edges shorten, becoming longer than wide distally, separate at first, becoming just contiguous distally. Three arm spines, rounded in cross section, tapering to a blunt tip, subequal, less than a segment in length basally, with middle spine slightly thickened. Uppermost spine reduced in size after basal segments, becoming absent after mid-arm. Lowermost spine becoming bottle-shaped with a narrow neck, which becomes curved, pseudo hook-shaped, on distal segments. Two small oval tentacle scales on first 4 segments, the one on the lateral arm plate larger than the one on the ventral arm plate, incompletely covering the pore. The smaller scale can be absent on the basal segments and is never present after the fourth.

Colour (dry): white.

Paratype 5.0 mm d.d. With similar morphology. Only 3 oral papillae, sometimes irregular in shape or position. Madreporite with rugose surface. Only 2 arm spines after the first few segments.

Distribution. New Caledonia (2040 m)

Remarks. These specimens have the two apical papillae and arm spine articulations characteristic of the Amphiridae (A.M. Clark 1970; Martynov 2010). Within that family we provisionally place them in the genus *Ophiodaphne* on the basis of similar oral frames, with oral shields smaller than the thick adoral shields which meet broadly within, arm plates and hooked distal arm

spines. The large female specimens of the type species, *Ophiodaphne formata* (Koehler, 1905), also have three oral papillae, but differ in having spiniform apical papillae and teeth, up to six cylindrical arm spines, narrow quadrangular radial shields, one oval tentacle scale and fine smooth disc plates (see Guille 1981). Large females of the second species, *Ophiodaphne scripta* (Koehler, 1904b) have a fused oral papilla with a minutely denticulate edge, fully contiguous D-shaped radial shields, small round disc plates marked by small grooves, a single wide tentacle scale, and several hook-shaped arm spines distally (see Cherbonnier & Guille 1978). In both previously-described species, the male is a dwarf that is frequently found clinging to the oral surface of the female, and they are generally found commensal with sand dollars (Tominaga et al. 2004) or (rarely) crinoids (Cherbonnier & Guille 1978). We refrained from dissecting the two known dry specimens of the new species and thus cannot determine their gender. Nor is there any information that these specimens were found in association with sea urchins or crinoids. In many ways the three species are quite morphologically diverse, and it is possible that the shared characters are convergent - perhaps adaptations to an epizoic lifestyle. The new species was found considerably deeper than the other two (0-630 m) which are widely distributed across the Indo-west Pacific Ocean. However, we see no advantage to assigning the new species to a separate genus until we have adequate molecular evidence. As discussed under the next species, further study is required to determine what characters are useful to define genera within the Amphiridae.

The mouth parts of *Ophiodaphne formata* and *O. scripta* are quite derived and there has been some debate whether they (and the similar sexually-dimorphic genus *Ophiophaera*) are better placed within the Amphiridae or Ophiactidae. Martynov (2010) however, found that both genera had arm spine articulations that are conclusively of the amphirid type.

Etymology. Named after the similar-looking impeller water pump that failed on TOH's attempted crossing of Bass Strait on the yacht Irene.

Amphipholis linopneusti Stöhr, 2001

Fig. 4

Amphira crassa (in part).--Koehler, 1904a: 83-84, pl. 15(1-2) [Non *Amphidia crassa* (Koehler, 1904); see Stöhr, 2001].

Amphidia crassa.--Koehler, 1922a: 167-168, pl. 69(11).--Clark, A.M., 1970: fig. 5c-d [Non *Amphidia crassa* (Koehler, 1904); see Stöhr, 2001].

Amphipholis linopneusti Stöhr, 2001: 319-322, fig. 1a-h.

Material examined. -- *New Caledonia*. BIOCAL: stn DW44, Ride de Norfolk, 22° 47.3'S, 167° 14.3'E, 440-450 m, 30 Aug 1985: 10 (MNHN IE.2013.16006). -- *EBISCO*: stn DW2613, Plateau des Chesterfield, 19° 37'S, 158° 41.9998'E, 519-522 m, 2005: 7 (MNHN IE.2007.7480). -- *Australia*. FR0688: stn 01, east of Cape York, Queensland, Australia, 10° 29.82'S, 144° 0.38'E, 495-534 m, 1988: 14 (AM J23292). -- *Papua New Guinea*. BIOPAPUA: stn CP3692, Pointe Sud-Est Manus Island, 2° 10'S, 147° 19'E, 408-448 m, 2010: 1 (MNHN IE.2012.686). -- BIOPAPUA: stn CP3645, Tami Island, Golfe de Huon, 6° 44'S, 147° 50'E, 403-418 m, 2010: 20 (MNHN IE.2012.319). -- *Vanuatu*. Santo: stn AT122, SE Malékula Island, 16° 37'S, 168° 0'E, 567-580 m, 2006: 1 (MNHN IE.2009.1990).

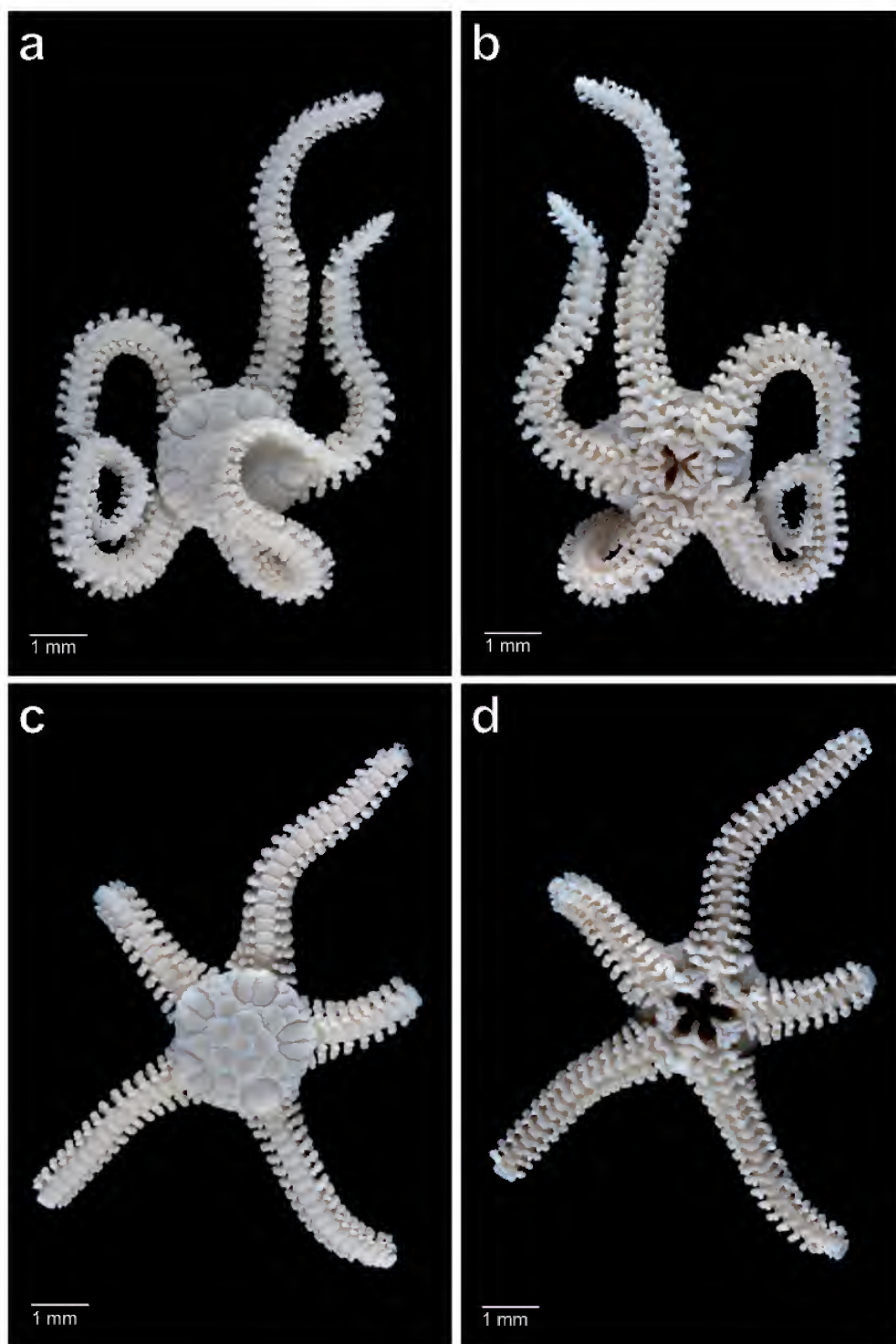


Figure 4. *Amphipholis linopneusti* Stöhr, 2001, MNHN IE.2013.16006, A, dorsal view of specimen 1, B, ventral view of specimen 1; C, dorsal view of specimen 2, D, ventral view of specimen 2.

Distribution. Fiji (260–651 m), New Caledonia and Vanuatu (440–580 m), NE Australia (495–534 m), Papua New Guinea (403–418 m), Indonesia (450–877 m), Philippines (?42–454 m)

Remarks. This species is sexually dimorphic. The lowermost basal arm spines of males are enlarged, sometimes flattened and hour-glass-shaped, whereas on the females they are cylindrical with a blunt rounded apex (Fig. 4). In many ways, this species is very divergent from other *Amphipholis* species. The disc scales are raised, with the radial shields in particular being surrounded by sunken borders. The arm spines are thick and short, almost capitate in some specimens. The single tentacle scale is large, often erect (on preserved material), hinged on the lateral arm plate but angled outward away from the mid-radius. The two oral papillae on the side of each jaw can vary in size, sometimes the inner one is larger, although it is always longer than wide and pointed proximally. The distal one is square to rectangular, typically wider than long. Unusually, the species is also epizoic on sea urchins.

Most *Amphipholis* species have two small tentacle scales (A.M. Clark, 1970). Exceptions include *Amphipholis vitax* Koehler, 1904a, (which also has atypical long narrow divergent radial shields), *A. pentacantha* H.L. Clark, 1915, *A. murmanica* Djakonov, 1929 and *A. nudipora* Koehler, 1914 which have rudimentary tentacle scales on basal segments or not at all. *Amphipholis tuberosa* Stöhr, 2011 also has only a few small tentacle scales basally. This species has tuberculated disc plates and is very similar to *Amphistigma watsonae* Baker, 1979. Finally *Amphipholis loripes* Koehler, 1922a was recently transferred to *Amphiodia* (*Amphispina*) by Stöhr, 2011 after spinous plates were discovered distal to the radial shields. These species do not have a homogeneous morphology. Indeed, genetic evidence (Hugall & O'Hara unpublished data) indicates that many amphiphiurid genera (*Amphiura*, *Amphipholis*, *Amphioplus*) are polyphyletic. We refrain from establishing a new genus for *A. linopneusti* until these genera are comprehensively revised.

There is also considerable morphological variation within *Amphipholis linopneusti*. As well as the sexual dimorphic characters, the number and shape of the other arm spines varies. There are up to seven arm spines in the BIOCAL stn DW44 lot (which contains only females). In the type series (Stöhr 2001), arm spines varied from being elongate (up to four times as long as wide) to small and stout (two times as long as wide). The shape of the oral shield also varies from round to triangular to oval (longer than wide). More research is required to determine whether this taxon includes one or more cryptic species. The taxon is distributed throughout the Indonesian-west-Pacific region at upper continental slope and rarely continental shelf (Koehler, 1922a) depths.

Acknowledgements

We thank Marc Eléaume, Nadia Améziane, Sarah Samadi and Juliette Delavenne for hosting or supporting several visits of TOH to the MNHN, and David Paul (Museum Victoria) for support using the Visionary digital Integrated System.

References

- Baker, A.N. (1979) Some Ophiuroidea from the Tasman Sea and adjacent waters. *New Zealand Journal of Zoology*, 6, 21–51.
- Baker, A.N. & Devaney, D.M. (1981) New records of Ophiuroidea (Echinodermata) from southern Australia, including new species of *Ophiacantha* and *Ophioneis*. *Transactions of the Royal Society of South Australia*, 105, 155–178, figs 1–98.
- Brock, J. (1888) Die Ophiuridenfauna des indischen Archipels. *Zeitschrift für Wissenschaftliche Zoologie*, 47, 465–539.
- Cherbonnier, G. & Guille, A. (1978) *Faune de Madagascar*. 48. *Echinodermes: Ophiurides*, Centre National de la Recherche Scientifique, Paris, 272 pp, 77 figs, 17 pls.
- Clark, A.H. (1949) Ophiuroidea of the Hawaiian Islands. *Bulletin of the Bernice Pauahi Bishop Museum*, 195, 3–133.
- Clark, A.M. (1953) A revision of the genus *Ophioneis* (Echinodermata: Ophiuroidea). *Proceedings of the Zoological Society of London*, 123, 65–94 figs 1–12 pls 1–3.
- Clark, A.M. (1970) Notes on the family Amphiphiuridae (Ophiuroidea). *Bulletin of the British Museum (Natural History), Zoology*, 19, 1–81.
- Clark, A.M. & Rowe, F.W.E. (1971) *Monograph of Shallow-water Indo-west Pacific Echinoderms*, Trustees of the British Museum (Natural History), London, 238 pp. 100 figs 31 pls.
- Clark, H.L. (1901) Echinoderms of Porto Rico. *Bulletin of the United States Fisheries Commission*, 20, 233–263.
- Clark, H.L. (1915) Catalogue of recent ophiurans: based on the collection of the Museum of Comparative Zoology. *Memoirs of the Museum of Comparative Zoology, Harvard University*, 25, 165–376, pls 1–20.
- Clark, H.L. (1923) The echinoderm fauna of South Africa. *Annals of the South African Museum*, 13, 221–435 figs 1–4 pls 8–23.
- Clark, H.L. (1946) The echinoderm fauna of Australia. Its composition and its origin. *Carnegie Institution of Washington Publication*, 566, 1–567.
- Djakonov, A.M. (1929) *Trudy Murmanskogo Biologicheskogo Stantsii*, 3.
- Duncan, P.M. (1879) On some Ophiuroidea from the Korean Seas. *Journal of the Linnean Society*, 14, 445–482, pls 9–11.
- Guille, A. (1981) Echinodermes: Ophiurides. *Mémoires de ORSTOM*, 91, 413–456, 4 figs, 9 pls.
- Hendler, G. (1995) Class Ophiuroidea: Brittle stars, Basket Stars. In: Hendler, G., Miller, J.E., Pawson, D.G. & Kier, P.M. (Eds). *Sea Stars, Sea Urchins, and Allies: Echinoderms of Florida and the Caribbean*, Smithsonian Institution Press, Washington & London, pp 89–195.
- Hugall, A. F., O'Hara, T. D., Hunjan, S., Nilsen, R. & Moussalli, A. (2015) An exon-capture system for the entire class Ophiuroidea. *BioRxiv*, doi:10.1101/014613.
- Koehler, R. (1904a) Ophiures de mer profonde. *Siboga-Expeditie*, 45, 1–176, pls 1–36.
- Koehler, R. (1904b) Ophiures nouvelles ou peu connues. *Mémoires de la Société Zoologique de France*, 17, 54–119, 98 figs.
- Koehler, R. (1905) Ophiures littorales. *Siboga-Expeditie Monographs*, 45, 1–142, pls 1–18.
- Koehler, R. (1913) Ophiures *Zoologische Jahrbucher Suppl.*, 11, 351–380, pls 20–21.
- Koehler, R. (1914) Echinoderma I. Asteroidea, Ophiuroidea et Echinoidea. In: Michaelsen, W. (Eds). *Beiträge zur Kenntnis der Meeresfauna Westafrikas Vol.1.*, L. Friederichsen & Co, Hamburg, pp 127–303, pls 4–5.
- Koehler, R. (1922a) Contributions to the biology of the Philippine Archipelago and adjacent regions. Ophiurans of the Philippine seas and adjacent waters. *Bulletin of the United States National Museum*, 100, 1–486, pls 1–103.

- Koehler, R. (1922b) Echinodermata: Ophiuroidea. *Scientific Reports. Australasian Antarctic Expedition Series C*, 8, 1-98, pls 76-90.
- Le Conte, J.L. (1851) Zoological Notes *Proceedings of the Academy of Natural Sciences of Philadelphia*, 5, 316-320.
- Liao, Y. & Clark, A.M. (1995) *The Echinoderms of Southern China*, Science Press, Beijing, 614 pp, 23 pls.
- Martynov, A.V. (2010) Reassessment of the classification of the Ophiuroidea (Echinodermata), based on morphological characters. I. General character evaluation and delineation of the families Ophiomyxidae and Ophiacanthidae. *Zootaxa*, 2697, 1-154.
- Matsumoto, H. (1917) A monograph of Japanese Ophiuroidea, arranged according to a new classification. *Journal of the College of Science, Imperial University Tokyo*, 38, 1-408, figs 1-100, pls 1-7.
- Mills, V.S. & O'Hara, T.D. (2013) Ophiuroids (Echinodermata; Ophiuroidea) of biogenic habitats on the continental shelf of New Zealand. *Zootaxa*, 3613, 401-444.
- Mortensen, T. (1936) Echinoidea and Ophiuroidea. *Discovery Reports*, 12, 199-348, 9 pls.
- Müller, J. & Troschel, F.H. (1844) Beschreibung neuer Asteriden. *Archiv für Naturgeschichte*, 10, 178-185.
- O'Hara, T.D. (1998) Mortensen's Pacific Expedition: Re-identification of ophiuroids (Echinodermata) from southern Australia. *Steenstrupia*, 24, 37-50.
- O'Hara, T.D. & Stöhr, S. (2006) Deep water Ophiuroidea (Echinodermata) of New Caledonia: Ophiacanthidae and Hemieuryalidae. *Tropical Deep Sea Benthos*, 193, 33-141.
- O'Hara, T.D., Hugall, A.F., Thuy, B. & Moussalli, A. (2014) Phylogenomic resolution of the Class Ophiuroidea unlocks a global microfossil record. *Current Biology*, 24, 1874-1879.
- Pitcher, C.R., Doherty, P.J., Arnold, P., Hooper, J.N.A. & Gribble, N.A. (2007) *Seabed biodiversity on the continental shelf of the Great Barrier Reef World Heritage Area.*, CSIRO Marine and Atmospheric Research, Brisbane, 319.
- Rowe, F.W.E. & Gates, J. (1995) *Zoological Catalogue of Australia. Vol. 33 Echinodermata.*, CSIRO Australia, Melbourne, 1-510 pp.
- Stöhr, S. (2001) *Amphipholis linopneusti* n.sp., a sexually dimorphic amphiuroid brittle star (Echinodermata: Ophiuroidea), epizoid on a spatangoid sea urchin. In: Barker, M. (Eds). *Echinoderms 2000. Proceedings of the 10th International Echinoderm Conference, Dunedin, New Zealand*, Balkema, Lisse, pp 317-322.
- Stöhr, S. (2011) New records and new species of Ophiuroidea (Echinodermata) from Lifou, Loyalty Islands, New Caledonia. *Zootaxa*, 3089, 1-50.
- Thuy, B. & Stöhr, S. (2011) Lateral arm plate morphology in brittle stars (Echinodermata: Ophiuroidea): new perspectives for ophiuroid micropalaeontology and classification. *Zootaxa*, 3013, 1-47.
- Tominaga, H., Nakamura, S. & Komatsu, M. (2004) Reproduction and development of the conspicuously dimorphic brittle star *Ophiodaphne formata* (Ophiuroidea). *Biological Bulletin (Woods Hole)*, 206, 25-34.

Sea cucumbers of the Kerguelen Plateau, with descriptions of new genus and species (Echinodermata: Holothuroidea)

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Abstract

O'Loughlin, P.M., Skarbnik-López, J., Mackenzie, M. and VandenSpiegel, D. 2015. Sea cucumbers of the Kerguelen Plateau, with descriptions of new genus and species (Echinodermata: Holothuroidea). *Memoirs of Museum Victoria* 73: 59–93.

A new genus of holothuroid, *Calcamariina* O'Loughlin, and five new species of holothuroids, with authors O'Loughlin & Skarbnik-López, from near Heard and McDonald Islands on the Kerguelen Plateau in the Southern Ocean are described: *Calcamariina hibberdi*, *Calcamariina moorea*, *Echinocucumis ampla*, *Psolus heardi*, *Paracaudina championi*. The new species *Paracaudina championi* has the diagnostic characters of both *Paracaudina* Heding and *Hedingia* Deichmann. *Molpadia violacea* Studer is raised out of synonymy with *Molpadia musculus* Risso. *Molpadia violacea* is reviewed, and an extended distribution around Antarctica is proposed. The distribution of *Molpadia magdae* O'Loughlin (in O'Loughlin *et al.*) is extended from the South Shetland Islands to Prydz Bay. *Pseudopsolus macquariensis* forma *gruui* Cherrbonnier & Guille is raised to species status. *Laevocnus* O'Loughlin (in O'Loughlin *et al.*) is an objective junior synonym of *Pentactella* Verrill. A *sensu stricto* diagnosis is provided for *Pentactella*. The always smaller, brood-protecting *Psolus ephippifer* Thomson specimens may be juveniles of the sympatric and always larger, non-brooding, *Psolus paradubiosus* Carriol & Féral specimens. Comprehensive lists are provided for all holothuroids that have been reported from the vicinity of Heard and McDonald Islands, and for the Kerguelen Plateau. Individual lists are provided for all holothuroid specimens from the vicinity of Heard and McDonald Islands that are held in Museum Victoria, the South Australian Museum, and the Tasmanian Museum and Art Gallery. Holothuroid species variably common to the Kerguelen Plateau, coast of Antarctica, Macquarie Island, Magellanic Region and Bouvetoya Island are listed.

Keywords

Antarctica, *Challenger*, *Gazelle*, HIMI, Bouvetoya, Heard, Kerguelen, Macquarie, Magellanic, new species, *Calcamariina*, *Echinocucumis*, *Hedingia*, *Molpadia*, *Paracaudina*, *Pentactella*, *Pseudopsolus*, *Psolus*.

Introduction

Heard and McDonald Islands are Australian territories (since 1947) on the southern Kerguelen Plateau that lies central-south of the Indian Ocean and south of the Antarctic Convergence. Heard and McDonald Islands and surrounding territorial waters were inscribed as a UNESCO World Heritage Site in 1997. Extending beyond the territorial waters is an Exclusive Economic Zone that includes four Marine Reserves. Names have been given to the principal regions within the EEZ (Figure 1 map). The Marine Reserves include

the *Coral* and *Aurora Banks* to the northwest, *Discovery Bank* to the north, and *Shell Bank* to the northeast. The Australian National Antarctic Research Expeditions (ANARE) was established in 1947 to conduct the Australian Antarctic program. In 1948 the Australian Antarctic Division (AAD) was established to administer the program. For the past decade the name ANARE has fallen out of use and been replaced by AAD. Following collecting from the Kerguelen Plateau by the HMS *Challenger* and SMS *Gazelle* in 1874, the US Transit of Venus Expedition in 1875, and The British

Australian and New Zealand Research Expedition (BANZARE) over the years 1929–1931, ANARE commenced expeditions in 1967 to the now Exclusive Economic Zone for Heard and McDonald Islands (HIMI).

A series of AAD marine survey expeditions has recovered an extensive collection of sea cucumbers from HIMI that are held by the Australian Antarctic Division at Kingston in southern Tasmania (specimens not registered), the Tasmanian Museum and Art Gallery in Hobart, the South Australia Museum in Adelaide, and Museum Victoria in Melbourne. Mark O'Loughlin has established the systematic identity of the specimens in NMV, SAM and TMAG. Ty Hibberd and Kirrily Moore determined the identity of specimens that have remained in the AAD facility at Kingston by comparison with voucher specimens identified by Mark O'Loughlin. Tissue samples from preserved specimens collected in recent surveys have been sent to Gustav Paulay in the University of Florida for genetic sequencing. COI sequences from some of these specimens have informed this study (see O'Loughlin *et al.* 2010). A comprehensive species list and individual museum specimen lists are provided below for all holothuroids reported from HIMI. Some other localities where HIMI species are reported are detailed and discussed.

The generic names *Thyone* Oken, 1815 and *Psolus* Oken, 1815 were introduced by Oken (1815) in a work that was suppressed by the ICZN in Opinion 417 because the paper was not consistently binominal. Gustav Paulay and Mark O'Loughlin have requested the ICZN to reinstate the names (Case 3598; *Bulletin of Zoological Nomenclature* 69(4) Dec 2012). The case is awaiting decision. We use the name *Psolus* Oken, 1815 provisionally.

Methods

Specimens collected by the FV *Southern Champion* were frozen and subsequently preserved in 70% ethanol. Tissue samples from recently preserved specimens were sent to Gustav Paulay (University of Florida) for molecular genetic sequencing. Jessica Skarbnik-López photographed the large specimens in this study with a Nikon D70 DSLR camera using a Nikkon 105 mm lens (and 2x adapter). Jessica Skarbnik-López and Melanie Mackenzie photographed the small specimens using a Leica DC5000 high-resolution digital camera system with auto montage software. Didier VandenSpiegel took the scanning electron microscope (SEM) images. Ossicles were cleared from tissue using commercial bleach, air dried, mounted on aluminium stubs and coated with gold. Observations were made using a JEOL JSM-6480LV SEM. Measurements were made with Smile view software. Slide photos of the Studer specimens on loan from ZMB were taken in NMV by Mark Darragh (see Figure 16). Melanie Mackenzie took the photo of the phosphatising *Molapdia* table through a microscope using a Canon PowerShot D30 waterproof camera.

Abbreviations

AAD	Australian Antarctic Division
AFMA	Australian Fisheries Management Authority
ANARE	Australian National Antarctic Research Expeditions
BANZARE	The British, Australian and New Zealand Antarctic Research Expedition
CEAMARC	Collaborative East Antarctic Marine Census
CSIRO	Commonwealth Scientific and Industrial Research Organization
EEZ	Exclusive Economic Zone
FAS	Fisheries Audit Services (NZ0 Ltd.)
HIMI	Heard and McDonald Islands territorial waters and Exclusive Economic Zone
ICZN	International Commission on Zoological Nomenclature
MNHN	Muséum national d'Histoire naturelle
MOL AF	UF tissues sequence code
NMV	Museum Victoria, with specimen registration prefix F
SAMA	South Australian Museum, with specimen registration prefix K
SC	Fishing Vessel <i>Southern Champion</i>
TMAG	Tasmanian Museum and Art Gallery, with registration prefix H
UF	Florida Museum of Natural History, University of Florida
USNM	United States National Museum of Natural History (Smithsonian Institution)
ZMB	Museum für Naturkunde – Leibniz Institute for Evolutionary and Biodiversity Research at the Humboldt University, Berlin.

Reports of HIMI holothuroids

In the first months of 1874 specimens representing five holothuroid species were collected from the HIMI region by HMS *Challenger* and reported by Théel (1886): *Pentactella laevigata* Verrill, 1876 (as *Cucumaria laevigata*) at *Challenger* Station 151 (immediately north of Heard I.; -52.99 73.59, 137 m); *Pentactella serrata* (Théel, 1886) (as *Cucumaria serrata*) at *Challenger* Station 150 (Coral Bank NW of Heard I.; -52.07 71.37, 274 m); *Pentactella intermedia* (Théel, 1886) (as *Cucumaria serrata* var *intermedia*) at *Challenger* Stations 150, 151 (see above); *Psolidium poriferum* (Studer, 1876) (= *Psolus incertus* Théel, 1886) at *Challenger* Stations 150, 151 (see above); *Psolus ephippifer* Thomson, 1877 at *Challenger* Stations 150, 151 (see above).

Subsequently the SMS *Gazelle* arrived at the Kerguelen Islands in October 1874 and collected holothuroid specimens representing five species that were reported by Studer (1876): *Pentactella laevigata* Verrill, 1876; *Psolidium poriferum* (Studer, 1876) (as *Cuvieria porifera* Studer, 1876); *Trachythyone muricata* Studer, 1876; *Molpadia violacea* Studer, 1876; *Sigmodota contorta* (Ludwig, 1875) (as *Sigmodota purpurea* Studer, 1876). All were from near the Kerguelen Islands, none from the HIMI region although all have been subsequently reported from HIMI. Mark O'Loughlin

examined the Studer holotypes while on loan to NMV from ZMB. Photos of the preserved Studer holotypes are provided in Figures 14 and 16.

In January 1875 *The United States Transit of Venus Expedition* collected *Pentactella laevigata* Verrill, 1876 from the Kerguelen Islands.

O'Loughlin (2009) reported on the BANZARE (1929–1931) holothuroids, some of which were collected from around the Kerguelen Islands but none from the HIMI region. Earlier, O'Loughlin (2002) had reported on selected BANZARE and ANARE holothuroids that included ANARE specimens from HIMI: *Heterocucumis godeffroyi* (Semper, 1867) (as *Cucumaria godeffroyi*); *Staruocucumis liouvillei* (Vaney, 1914); *Trachythyone lechleri* (Lampert, 1885); *Sigmodota contorta* (Ludwig, 1875) (as *Chiridota pisanii* Ludwig, 1887). Three specimens from HIMI that were listed by O'Loughlin & VandenSpiegel (2010) under *Sigmodota contorta* were subsequently identified as *Paradota weddellensis* Gutt, 1990.

Eight marine expeditions to HIMI, commencing in 1967, have collected holothuroid specimens (Table 1). A map is provided for the various regions of the HIMI (Figure 1). In this paper we report all holothuroid species collected from the HIMI region (Table 2), and the individual specimens held in NMV (Table 3), SAMA (Table 4), and TMAG (Table 5).

Hibberd & Moore (2009) have provided a field guide to the holothuroids of HIMI that is available on-line at: http://heardisland.antarctica.gov.au/__data/assets/pdf_file/0015/2166/HIMI_Invertebrate_Identification_guide1.pdf

We note that this paper indicates a need for an update of this guide. Reidentifications and new species are reported below.

Order **Dendrochirotida** Grube, 1840

Family **Cucumariidae** Ludwig, 1894

Subfamily **Cucumariinae** Ludwig, 1894 *sensu* Panning 1949

Remarks. The subfamily Cucumariinae has plates only in the body wall, while the second subfamily Colochirinae Panning, 1949 has plates and cup/basket ossicles in the body wall.

Calcamariina O'Loughlin gen. nov.

Zoobank LSID. <http://zoobank.org:act:C8E4BCE3-5C82-421B-A0F5-49990CC0FE8E>

Diagnosis. Cucumariinid genus; body fusiform, up-turned tail; tentacles eight and two small ventral; complete calcareous body cover of imbricating thick, single-layered, knobbed, perforated plates, or thick, knobbed, rod-plates, some plates and rod-plates with spinous or knobbed part-margins; complete cover of tube feet surmounting calcareous papillae; absence of cups and tables; tentacles with thick rod-plates, rods and small perforated plates, lacking rosettes.

Type species and locality. *Calcamariina hibberdi* O'Loughlin & Skarbnik-López sp. nov. (south Kerguelen Plateau)

Second assigned species. *Calcamariina moorea* O'Loughlin & Skarbnik-López sp. nov. (south Kerguelen Plateau)

Etymology. Named *Calcamariina* from the Latin *calx* (meaning “chalk/limestone”, referring to the calcareous body wall), and *mariina* (from the sub-family Cucumariinae).

Remarks. The complete body-cover of thick, calcareous single-layered perforated plates or rod-plates some with spinous or knobbed part-margins, complete cover of tube feet surmounting calcareous papillae, and absence of cups or tables, is a unique generic combination amongst the cucumariinid genera. There are no near-similar genera. We are most reluctant to establish yet another genus, but we cannot find a cucumariinid genus into which we can provisionally assign the new species.

Calcamariina hibberdi O'Loughlin & Skarbnik-López sp. nov.

Zoobank LSID. <http://zoobank.org:act:548D6DA2-AAC9-4C4C-B403-56BD914DD3CE>

Tables 1–3, 5, 6; figures 1–3, 6.

Material examined. Holotype. Southern Ocean, S Kerguelen Plateau, NE Heard Island, *Shell Bank*, AAD *Southern Champion* cruise 46 haul 125, beam trawl, -51.69 76.19, 234 m, 25 Jun 2007, NMV F165750 (UF tissue sequence code MOL AF703).

Paratypes. HIMI, *Aurora Bank*, SC26(184), 247 m, 1 May 2003, TMAG H3542 (1); S *Shell Bank*, SC26(253), 341 m, 8 May 2003, TMAG H3543 (1).

Description. Body fusiform with slightly up-turned oral and anal ends, anal end tapered to a tail, curved semi-U-shaped body up to 15 mm wide (U-shape width), mid-body diameter up to 6 mm (TMAG H3543); body grey/off-white, hard, calcareous, covered with low rounded calcareous papillae each with apical terminal tube foot, papillae with tube feet more numerous ventrally than dorsally. Five anal scales. Calcareous ring cucumariid-like, plates with high anterior radial and inter-radial prolongations, lacking posterior prolongations. Tentacles dendritic, 8 large, 2 ventral small. Single polian vesicle.

Ossicles of body wall and bases of papillae thick perforated plates, irregularly oval to elongate to triangular, perforations never two large perforations centrally in plates, single-layered, variably knobbed on plate surface and thickened, generally smooth at the end embedded in the body wall, many with spinous marginal projections at narrow end of plate that projects from the body wall, ossicles up to about 550 μ m long. Extended tube feet above papillae about 650 μ m long; tube feet with endplates and support plates; endplate diameters variable, up to about 200 μ m; tube foot/papilla wall supported by an open curved mesh of contiguous small perforated plates and rod-plates, elongate, curved, variable form but typically with four large central perforations and few distal small perforations, inner concave plate margin smooth, outer convex margin with blunt denticulations, plates up to about 140 μ m long. Tentacles with small concave perforated plates, marginally denticulate, about 60–100 μ m

across; curved, thick, perforated plates, perforated rod-plates and rods, bluntly denticulate on the outer margin, up to 320 μm long; lacking rosettes.

Distribution. Southern Ocean, S Kerguelen Plateau, *Aurora* and *Shell Banks*, 234–341 m.

Etymology. Named for Ty Hibberd who followed Kirrily Moore in the curation and identification of the HIMI collections, and with appreciation of his generous collaboration on the systematics of sea cucumbers from Eastern Antarctica and HIMI.

Remarks. The holotype was donated to NMV by the AAD. Initial preservation was by freezing, with subsequent transfer to 70% ethanol. The combination of generic diagnostic characters of *Calcamariina* O'Loughlin gen. nov.

distinguishes the two species *Calcamariina hibberdi* O'Loughlin & Skarbnik-López sp. nov. and *Calcamariina moorea* O'Loughlin & Skarbnik-López sp. nov. (below) from all other cucumariinid species. *Calcamariina hibberdi* is in turn distinguished from *Calcamariina moorea* (below) in the Remarks for that species. The paratypes above were taken by *Southern Champion* cruise 26 and are registered in TMAG. There are probably more specimens of this new species held but not registered and not readily accessible in the AAD in Kingston.

The superficially similar species *Neopsolidium kerguelensis* (Théel, 1886) that also occurs on the Kerguelen Plateau is distinguished from the *Calcamariina* species by the former having narrow bare ventral inter-radii, and cups and multi-layered ossicles in the body wall (illustrated here in Figure 6).

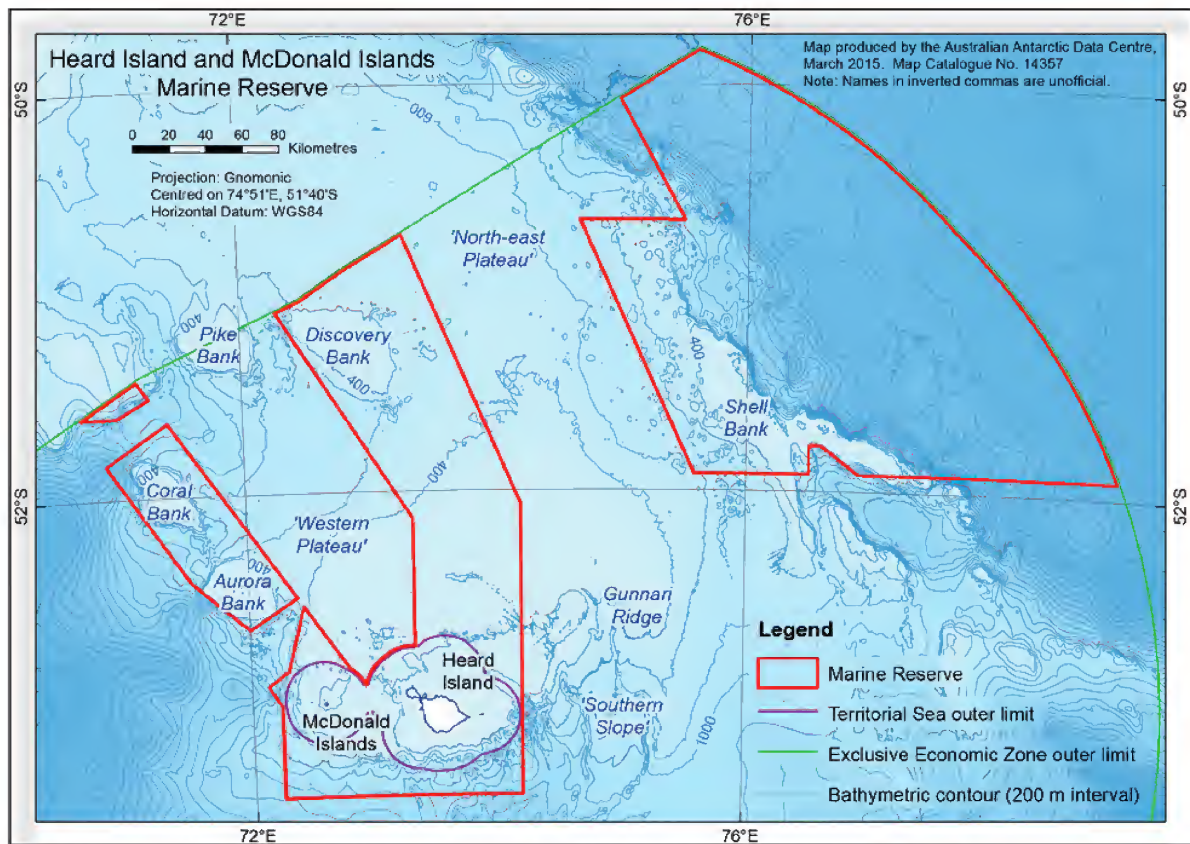


Figure 1. Map of the southern part of the Kerguelen Plateau detailing the Heard and McDonald Islands Territorial Sea, Exclusive Economic Zone, Marine Reserve and localities (map is courtesy of the Australian Antarctic Division © Commonwealth of Australia 2015). Names on the map in commas are used in this study but not formally recognized by the AAD.

Table 1. Voyages to HIMI that collected Holothuroidea specimens.

Year, code	Research vessel, cruise	Collector	Museum collection	Locations visited
1967 AD ¹	<i>Umitaka Maru</i>	R. Poole	NMV	off Heard Island
1985 HRD	<i>Nella Dan</i>	M. Norman	NMV	off Heard Island
1990 AA	<i>Aurora Australis</i> V7	W. Zeidler, L. Hobbs	SAMA	<i>Aurora</i> , <i>Coral</i> , <i>Discovery</i> , <i>Pike</i> , <i>Shell Banks</i> , <i>Gunnari Ridge</i> , off Heard I., off McDonald Is, North-east Plateau, Southern Slope
1992 AA	<i>Aurora Australis</i> V2	C. Materia	NMV	<i>Aurora</i> , <i>Pike</i> , <i>Shell Banks</i> , <i>Gunnari Ridge</i> , off Heard I., North-east Plateau, Southern Slope, Western Plateau
1993 HRD	<i>Aurora Australis</i> V1	T. Stranks	NMV	<i>Gunnari Ridge</i> , Heard I., North-east Plateau, <i>Shell Bank</i> , Southern Slope
2003 SC	<i>Southern Champion</i> 26	² T. Lamb, ³ S. Davenport, ⁴ C. Sutherland	AAD, TMAG	<i>Aurora</i> , <i>Coral</i> , <i>Shell Banks</i> , Western Plateau
2007 SC	<i>Southern Champion</i> 46	² R. Kilpatrick, ³ J. Hamill, ⁴ T. Cantwell	AAD, NMV	<i>Shell Bank</i> , North-east Plateau
2008 SC	<i>Southern Champion</i> 50	³ J. Hamill, ⁴ T. Cantwell	AAD, NMV	<i>Gunnari Ridge</i> , <i>Pike Bank</i> , Southern Slope

Notes for Table 1: ¹ Data in CSIRO 'Cronulla files'; ² AAD; ³ AFMA; ⁴ FAS

Table 2. Holothuroidea species from HIMI (systematic identity established by Mark O'Loughlin).

Order	Species	AAD code
Aspidochirotia	<i>Pseudostichopus peripatus</i> (Sluiter, 1901) ¹	HOL 17
	<i>Pseudostichopus spiculiferus</i> (O'Loughlin, 2002) ¹	HOL 9
	<i>Zygothuria lactea</i> (Théel, 1886) ¹	HOL 26
	<i>Synallactes</i> species ²	HOL 2
Dendrochirotida	<i>Calcamariina hibberdi</i> O'Loughlin & Skarbnik-López sp. nov.	None
	<i>Calcamariina moorea</i> O'Loughlin & Skarbnik-López sp. nov.	HOL 14
	<i>Echinocucumis ampla</i> O'Loughlin & Skarbnik-López sp. nov.	HOL 10
	<i>Heterocucumis godeffroyi</i> (Semper, 1867)	HOL. 4
	<i>Neopsolidium kerguelensis</i> (Théel, 1886)	HOL 19
	<i>Pentactella intermedia</i> (Théel, 1886) ³	HOL 20
	<i>Pentactella laevigata</i> Verrill, 1876 ³	HOL 3
	<i>Pentactella serrata</i> (Théel, 1886) ³	HOL 21
	<i>Psolidium poriferum</i> (Studer, 1876)	HOL 7

Order	Species	AAD code
	<i>Psolus antarcticus</i> (Philippi, 1857) ⁴	HOL 23
	<i>Psolus ephippifer</i> Thomson, 1877 ⁵	HOL 15
	<i>Psolus paradubiosus</i> Carriol & Féral, 1985 ⁵	HOL 6
	<i>Psolus heardi</i> O'Loughlin & Skarbnik-López sp. nov.	HOL 23
	<i>Staurocucumis liouvillei</i> (Vaney, 1914) ⁶	HOL 1
	<i>Trachythyone lechleri</i> (Lampert, 1885)	None
	<i>Trachythyone muricata</i> Studer, 1876	HOL 8
Molpadida	<i>Paracaudina championi</i> O'Loughlin & Skarbnik-López sp. nov.	HOL 11
	<i>Molpadia violacea</i> Studer, 1876 ⁷	HOL 12
Synaptida	<i>Sigmodota contorta</i> (Ludwig, 1875)	None
(Apodida)	<i>Paradota weddellensis</i> Gutt, 1990	HOL 5

Notes on determinations in Table 2:

¹Uncertain determinations; lack supporting genetic data.

²Probable new species (very damaged specimen).

³Phylogenetic CO1 tree in O'Loughlin *et al.* 2014 supports discrete species.

⁴CO1 sequence clades with *Psolus antarcticus* specimens from Antarctica and Bouvetoya Island within a species complex.

⁵Similar morphological appearance and ossicles. The always smaller, brood-protecting *Psolus ephippifer* may be juveniles of the sympatric and always larger, non-brood-protecting *Psolus paradubiosus*.

^{6,7}CO1 sequences clade closely with those of Antarctic coast specimens. (See phylogenetic trees in O'Loughlin *et al.* 2010).

Museum Specimens of HIMI Holothuroidea

Many specimens of HIMI Holothuroidea are held at the AAD in Kingston (Tasmania) and cannot be readily accessed. Those that are registered in museum collections and accessible are listed in the three tables below.

Table 3. Holothuroidea specimens from HIMI held in NMV.

Reg No NMV F	Species	Station	Lat. Long.	Depth m	Date collected
165750	<i>Calcamariina hibberdi</i> sp. nov.	SC46(125)	-51.69 76.19	234	25/06/2007
85002	<i>Calcamariina moorea</i> sp. nov.	AA92 28	-51.56 76.04	230-247	30/01/1992
85003	<i>Calcamariina moorea</i> sp. nov.	HRD93 71 S	-50.72 75.07	514-528	28/09/1993
85004	<i>Calcamariina moorea</i> sp. nov.	HRD 006	-53.00 73.38	60	03/10/1985
165735	<i>Echinocucumis ampla</i> sp. nov.	SC46(479)	-50.68 74.62	708	30/07/2007
198492	<i>Echinocucumis ampla</i> sp. nov.	SC46(479)	-50.68 74.62	708	30/07/2007
85001	<i>Heterocucumis godeffroyi</i>	HRD93 49 B	-52.61 75.29	209	18/09/1993
84999	<i>Heterocucumis godeffroyi</i>	AA92 35	-51.27 75.61	367-379	31/01/1992
85000	<i>Heterocucumis godeffroyi</i>	AA92 29	-51.64 76.03	235-250	30/01/1992
110516	<i>Heterocucumis godeffroyi</i>	HRD93 71 S	-50.72 75.07	514-528	28/09/1993

Reg No NMV F	Species	Station	Lat. Long.	Depth m	Date collected
110520	<i>Heterocucumis godeffroyi</i>	AA92 41	-51.29 71.98	250-252	03/02/1992
76842	<i>Molpadia violacea</i>	AD 40	-52.95 73.34	112	03/02/1967
165737	<i>Molpadia violacea</i>	SC50(010)	-51.31 71.77	273	31/05/2008
84997	<i>Neopsolidium kerguelensis</i>	HRD 007	-53.16 73.22	62-80	04/10/1985
165736	<i>Paracaudina championi</i> sp. nov.	SC46(479)	-50.68 74.62	708	30/07/2007
84977	<i>Paradota weddellensis</i>	AA92 01	-52.94 73.36	159-176	23/01/1992
84978	<i>Paradota weddellensis</i>	AA92 08	-52.68 72.94	215-228	25/01/1992
84979	<i>Paradota weddellensis</i>	AA92 06	-53.21 73.68	120-132	24/01/1992
84982	<i>Pentactella intermedia</i>	HRD 007	-53.16 73.22	62-80	04/10/1985
84984	<i>Pentactella intermedia</i>	HRD 002	-53.02 73.83	85-93	02/10/1985
85009	<i>Pentactella laevigata</i>	AD 41	-52.93 73.34	177	03/02/1967
71905	<i>Pentactella laevigata</i>	AA92 01	-52.94 73.36	159-176	23/01/1992
66723	<i>Pentactella laevigata</i>	AA92 42	-51.35 71.78	297-301	03/02/1992
66726	<i>Pentactella laevigata</i>	AA92 33	-51.53 75.45	506-510	31/01/1992
67296	<i>Pentactella laevigata</i>	AA92 50	-52.46 72.42	449-457	08/02/1992
66724	<i>Pentactella laevigata</i>	AA92 43	-51.30 71.93	252-248	05/02/1992
67298	<i>Pentactella laevigata</i>	AA92 43	-51.30 71.93	252-248	05/02/1992
66732	<i>Pentactella laevigata</i>	AA92 24	-52.19 74.89	274-288	29/01/1992
67312	<i>Pentactella laevigata</i>	AA92 12	-52.71 74.22	190-202	26/01/1992
66729	<i>Pentactella laevigata</i>	AA92 13	-52.71 74.46	185-204	26/01/1992
85010	<i>Pentactella laevigata</i>	HRD93 20 B	-51.27 75.69	265-281	08/09/1993
85008	<i>Pentactella laevigata</i>	HRD93 49 B	-52.61 75.29	209	18/09/1993
85013	<i>Pentactella laevigata</i>	AA92 06	-53.21 73.68	120-132	24/01/1992
66728	<i>Pentactella laevigata</i>	AA92 29	-51.64 76.03	235-250	30/01/1992
85011	<i>Pentactella laevigata</i>	HRD 006	-53.00 73.38	60	03/10/1985
67297	<i>Pentactella laevigata</i>	AA92 48	-52.42 72.11	226-231	06/02/1992
85007	<i>Pentactella laevigata</i>	HRD93 51 B	-52.85 74.14	173	18/09/1993
66725	<i>Pentactella laevigata</i>	AA92 09	-52.53 73.16	229	25/01/1992
71904	<i>Pentactella laevigata</i>	AA92 17	-52.68 75.16	205-297	27/01/1992
66730	<i>Pentactella laevigata</i>	AA92 08	-52.68 72.94	215-228	25/01/1992
71903	<i>Pentactella laevigata</i>	AA92 14	-52.68 75.02	410-513	26/01/1992
66731	<i>Pentactella laevigata</i>	AA92 19	-52.74 75.10	391-421	28/01/1992

Reg No NMV F	Species	Station	Lat. Long.	Depth m	Date collected
85012	<i>Pentactella laevigata</i>	HRD 008	-53.20 73.10	200	04/10/1985
85014	<i>Pentactella laevigata</i>	HRD 008	-53.20 73.10	200	04/10/1985
85006	<i>Pentactella laevigata</i>	HRD93 50 B	-52.75 74.14	189	18/09/1993
71902	<i>Pentactella laevigata</i>	AA92 05	-52.92 74.14	149-172	24/01/1992
85005	<i>Pentactella laevigata</i>	HRD93 71 S	-50.72 75.07	514-528	28/09/1993
66727	<i>Pentactella laevigata</i>	AA92 41	-51.29 71.98	250-252	03/02/1992
165738	<i>Pentactella laevigata</i>	SC50(258)	-52.44 75.18	265	30/06/2008
84981	<i>Pentactella serrata</i>	AA92 35	-51.27 75.61	367-379	31/01/1992
165742	<i>Pentactella serrata</i>	SC46(124)	-51.72 76.33	228	25/06/2007
165746	<i>Pentactella serrata</i>	SC46(125)	-51.69 76.19	234	25/06/2007
165749	<i>Pseudostichopus peripatus</i>	SC46(478)	-50.59 75.91	799	30/07/2007
165751	<i>Pseudostichopus peripatus</i>	SC46(113)	-51.81 76.80	297	24/06/2007
165740	<i>Pseudostichopus peripatus</i>	SC50(050)	-52.71 74.92	558	04/06/2008
165739	<i>Pseudostichopus spiculiferus</i>	SC46(126)	-51.70 76.41	279	25/06/2007
66849	<i>Psolidium poriferum</i>	AA92 13	-52.71 74.46	185-204	26/01/1992
66850	<i>Psolidium poriferum</i>	AA92 09	-52.53 73.16	229	25/01/1992
165743	<i>Psolidium poriferum</i>	SC46(124)	-51.72 76.33	228	25/06/2007
168624	<i>Psolus antarcticus</i>	SC50(010)	-51.31 71.77	273	31/05/2008
165741	<i>Psolus antarcticus</i>	SC50(010)	-51.31 71.77	273	31/05/2008
66733	<i>Psolus ehippifer</i>	AA92 13	-52.71 74.46	185-204	26/01/1992
84987	<i>Psolus ehippifer</i>	HRD93 71 S	-50.72 75.07	514-528	28/09/1993
67099	<i>Psolus ehippifer</i>	AA92 06	-53.21 73.68	120-132	24/01/1992
84988	<i>Psolus ehippifer</i>	HRD93 54 B	-52.49 74.85	244-248	19/09/1993
84989	<i>Psolus ehippifer</i>	HRD 006	-53.00 73.38	60	03/10/1985
67100	<i>Psolus ehippifer</i>	AA92 48	-52.42 72.11	226-231	06/02/1992
165747	<i>Psolus ehippifer</i>	SC50(010)	-51.31 71.77	273	31/05/2008
84986	<i>Psolus heardi</i> sp. nov.	HRD93 71 'S'	-50.72 75.07	514-528	28/09/1993
198493	<i>Psolus heardi</i> sp. nov.	HRD93 71 'S'	-50.72 75.07	514-528	28/09/1993
84991	<i>Psolus paradubiosus</i>	HRD93 21 B	-51.29 75.43	337-541	08/09/1993
84990	<i>Psolus paradubiosus</i>	HRD93 68 BA	-51.68 76.50	214-220	24/09/1993
110513	<i>Sigmodota contorta</i>	AA92 29	-51.64 76.03	235-250	30/01/1992
85031	<i>Staurocucumis liouvillei</i>	AA92 01	-52.94 73.36	159-176	23/01/1992

Reg No NMV F	Species	Station	Lat. Long.	Depth m	Date collected
85023	<i>Staurocucumis liouvillei</i>	AA92 42	-51.35 71.78	297-301	03/02/1992
85029	<i>Staurocucumis liouvillei</i>	AA92 43	-51.30 71.93	252-248	05/02/1992
85028	<i>Staurocucumis liouvillei</i>	AA92 41	-51.29 71.98	250-252	03/02/1992
85025	<i>Staurocucumis liouvillei</i>	HRD93 48 B	-52.24 74.34	254	18/09/1993
85020	<i>Staurocucumis liouvillei</i>	HRD93 17 B	-51.59 75.92	243-260	07/09/1993
85019	<i>Staurocucumis liouvillei</i>	HRD93 64 B	-51.38 75.82	250-260	23/09/1993
85021	<i>Staurocucumis liouvillei</i>	HRD93 68 B	-51.70 76.52	217-228	24/09/1993
85034	<i>Staurocucumis liouvillei</i>	AA92 06	-53.21 73.68	120-132	24/01/1992
85026	<i>Staurocucumis liouvillei</i>	AA92 06	-53.21 73.68	120-132	24/01/1992
85032	<i>Staurocucumis liouvillei</i>	AA92 06	-53.21 73.68	120-132	24/01/1992
85018	<i>Staurocucumis liouvillei</i>	HRD93 21 B	-51.29 75.43	337-541	08/09/1993
85022	<i>Staurocucumis liouvillei</i>	HRD93 69 B	-51.67 76.36	218	24/09/1993
85024	<i>Staurocucumis liouvillei</i>	HRD 006	-53.00 73.38	60	03/10/1985
85030	<i>Staurocucumis liouvillei</i>	AA92 02	-53.00 73.72	108-115	23/01/1992
84996	<i>Staurocucumis liouvillei</i>	HRD 008	-53.20 73.10	200	04/10/1985
85016	<i>Staurocucumis liouvillei</i>	HRD93 51 B	-52.85 74.14	173	18/09/1993
85015	<i>Staurocucumis liouvillei</i>	HRD93 50 B	-52.75 74.14	189	18/09/1993
85033	<i>Staurocucumis liouvillei</i>	HRD93 18 B	-51.55 76.07	191-231	07/09/1993
85017	<i>Staurocucumis liouvillei</i>	HRD93 56 B	-52.52 74.89	279	19/09/1993
85027	<i>Staurocucumis liouvillei</i>	AA92 05	-52.92 74.14	149-172	24/01/1992
135032	<i>Staurocucumis liouvillei</i>	HRD 008	-53.20 73.10	200	04/10/1985
165744	<i>Staurocucumis liouvillei</i>	SC46(125)	-51.69 76.19	234	25/06/2007
165748	<i>Staurocucumis liouvillei</i>	SC46(125)	-51.69 76.19	234	25/06/2007
110518	<i>Staurocucumis liouvillei</i>	AA92 08	-52.68 72.94	215-228	25/01/1992
110519	<i>Staurocucumis liouvillei</i>	AA92 19	-52.74 75.10	391-421	28/01/1992
110514	<i>Staurocucumis liouvillei</i>	AA92 09	-52.53 73.16	229	25/01/1992
110517	<i>Staurocucumis liouvillei</i>	AA92 50	-52.46 72.42	449-457	08/02/1992
110515	<i>Staurocucumis liouvillei</i>	AA90 40	-51.15 74.36	~420-429	06/06/1990
84993	<i>Trachythyone lechleri</i>	AA92 01	-52.94 73.36	159-176	23/01/1992
84992	<i>Trachythyone lechleri</i>	AA92 06	-53.21 73.68	120-132	24/01/1992
84995	<i>Trachythyone lechleri</i>	HRD 006	-53.00 73.38	60	03/10/1985
84994	<i>Trachythyone lechleri</i>	AA92 09	-52.53 73.16	229	25/01/1992
165745	<i>Trachythyone muricata</i>	SC46(127)	-51.63 75.81	362	25/06/2007

Table 4. Holothuroidea specimens from HIMI held in SAMA.

Reg. No. SAMA K	Species	Station AA90	Lat. Long.	Depth m	Date collected 1990
2307	<i>Pseudostichopus peripatus</i>	61	-52.56 72.3	655-800	11/6
2308	<i>Pseudostichopus peripatus</i>	20	-52.41 71.81	275	1/6
2309	<i>Pseudostichopus peripatus</i>	16	-52 71.33	290	30/5
2310	<i>Pseudostichopus peripatus</i>	31	-51.81 76.2	275	4/6
2311	<i>Pseudostichopus peripatus</i>	19	-52.41 71.81	275	31/5
2312	<i>Pentactella laevigata</i>	41	-51.16 72.98	270	7/6
2313	<i>Pentactella laevigata</i>	14	-51.88 71.31	300	29/5
2314	<i>Pentactella laevigata</i>	19	-52.41 71.81	275	31/5
2315	<i>Pentactella laevigata</i>	42	-51.21 74.68	270	7/6
2316	<i>Pentactella laevigata</i>	19	-52.41 71.81	275	31/5
2317	<i>Pentactella laevigata</i>	76	-53.2 73.73	130	19/6
2318	<i>Pentactella laevigata</i>	4	-51.71 76.53	230	24/5
2319	<i>Pentactella laevigata</i>	14	-51.88 71.31	300	29/5
2320	<i>Pentactella laevigata</i>	14	-51.88 71.31	300	29/5
2321	<i>Pentactella laevigata</i>	76	-53 73.7	90	18/6
2322	<i>Pentactella laevigata</i>	80	-52.68 73	210	20/6
2323	<i>Pentactella laevigata</i>	18	-52.41 71.81	320	31/5
2324	<i>Pentactella laevigata</i>	23	-52.91 74.23	165	2/6
2326	<i>Pentactella laevigata</i>	44	-51.28 72.03	260	7/6
2327	<i>Pentactella laevigata</i>	82	-53.15 73.18	175	20/6
2328	<i>Pentactella laevigata</i>	78	-52.91 74.08	200	19/6
2329	<i>Pentactella laevigata</i>	47	-51.28 73.01	280	8/6
2330	<i>Pentactella laevigata</i>	78	-52.91 74.08	200	19/6
2331	<i>Pentactella laevigata</i>	2	-52.71 75.13	380	23/5
2332	<i>Pentactella laevigata</i>	57	-52.2 72.66	430	10/6
2333	<i>Pentactella laevigata</i>	78	-52.91 74.08	200	19/6
2334	<i>Pentactella laevigata</i>	7	-51.26 75.63	285	25/5
2335	<i>Pentactella laevigata</i>	24	-52.7 74.53	200	2/6
2336	<i>Pentactella laevigata</i>	25	-52.58 74.75	300	2/6
2337	<i>Pentactella laevigata</i>	60	-52.56 72.18	260-380	11/6
2338	<i>Pentactella laevigata</i>	70	-52.05 74.16	280	14/6

Reg. No. SAMA K	Species	Station AA90	Lat. Long.	Depth m	Date collected 1990
2305	<i>Pentactella intermedia</i>	76	-53 73.7	90	18/6
2304	<i>Neopsolidium kerguelensis</i>	76	-53 73.7	90	18/6
2287	<i>Staurocucumis liouvillei</i>	32	-51.63 76.05	250	4/6
2288	<i>Staurocucumis liouvillei</i>	4	-51.71 76.53	230	24/5
2289	<i>Staurocucumis liouvillei</i>	76	-53.2 73.73	130	19/6
2290	<i>Staurocucumis liouvillei</i>	5	-51.55 76.05	240	24/5
2291	<i>Staurocucumis liouvillei</i>	16	-52 71.33	290	30/5
2292	<i>Staurocucumis liouvillei</i>	33	-51.56 75.88	270	4/6
2293	<i>Staurocucumis liouvillei</i>	6	-51.38 75.81	260	25/5
2294	<i>Staurocucumis liouvillei</i>	14	-51.88 71.31	300	29/5
2295	<i>Staurocucumis liouvillei</i>	41	-51.16 72.98	270	7/6
2296	<i>Staurocucumis liouvillei</i>	47	-51.28 73.01	280	8/6
2297	<i>Staurocucumis liouvillei</i>	42	-51.21 74.68	270	7/6
2298	<i>Staurocucumis liouvillei</i>	19	-52.41 71.81	275	31/5
2299	<i>Staurocucumis liouvillei</i>	49	-51.3 74.05	420	8/6
2300	<i>Staurocucumis liouvillei</i>	39	-51.15 74.33	450	6/6
2301	<i>Staurocucumis liouvillei</i>	12	-51.35 71.86	290	29/5
2302	<i>Staurocucumis liouvillei</i>	82	-53.15 73.18	175	20/6
2325	<i>Staurocucumis liouvillei</i>	2	-52.71 75.13	380	23/5
2303	<i>Trachythone muricata</i>	53	-51.83 73.38	470	9/6
2189	<i>Psolidium poriferum</i>	78	-52.91 74.08	200	19/6
2190	<i>Psolidium poriferum</i>	60	-52.56 72.18	260-380	11/6
2191	<i>Psolidium poriferum</i>	44	-51.28 72.03	260	7/6
2205	<i>Psolidium poriferum</i>	61	-52.56 72.3	720	11/6
2192	<i>Psolus ephippifer</i>	76	-53.2 73.73	130	19/6
2193	<i>Psolus ephippifer</i>	47	-51.28 73.01	280	8/6
2194	<i>Psolus ephippifer</i>	41	-51.16 72.98	270	7/6
2195	<i>Psolus ephippifer</i>	19	-52.41 71.81	275	31/5
2200	<i>Psolus ephippifer</i>	82	-53.15 73.18	175	20/6
2196	<i>Psolus paradubiosus</i>	31	-51.81 76.2	275	4/6
2197	<i>Psolus paradubiosus</i>	21	-52.8 72.43	230	1/6
2198	<i>Psolus paradubiosus</i>	44	-51.28 72.03	260	7/6

Reg. No. SAMA K	Species	Station AA90	Lat. Long.	Depth m	Date collected 1990
2199	<i>Psolus paradubiosus</i>	6	-51.38 75.81	260	25/5
2201	<i>Psolus paradubiosus</i>	59	-52.43 72.15	235	11/6
2202	<i>Psolus paradubiosus</i>	76	-53.2 73.73	130	19/6
2203	<i>Psolus paradubiosus</i>	19	-52.41 71.81	275	31/5
2204	<i>Psolus paradubiosus</i>	4	-51.71 76.53	230	24/5
2206	<i>Psolus paradubiosus</i>	82	-53.15 73.18	175	20/6
2207	<i>Psolus paradubiosus</i>	60	-52.56 72.18	260-380	11/6
2306	<i>Molpadia violacea</i>	76	-53.2 73.73	130	19/6

Table 5. Holothuroidea specimens from HIMI held in TMAG.

Reg. No. TMAG	Species	Station SC26	Lat. Long.	Depth m	Date 2003
H3239	<i>Synallactes species</i>	267	-51.82 76.02	472	10/5/2003
H3291	<i>Synallactes species</i>	267	-51.82 76.02	472	10/5/2003
H3289	<i>Pseudostichopus peripatus</i>	275	-51.76 76.44	268	10/5/2003
H3430	<i>Pseudostichopus peripatus</i>	201	-52.07 71.50	297	2/3/2003
H3290	<i>Pseudostichopus spiculiferus</i>	275	-51.76 76.44	268	10/5/2003
H3538	<i>Pseudostichopus spiculiferus</i>	255	-51.83 76.90	290	9/5/2003
H3303	<i>Psolidium poriferum</i>	173	-52.35 72.74	264	30/4/2003
H3304	<i>Psolidium poriferum</i>	178	-52.42 71.88	263	1/5/2003
H3305	<i>Psolidium poriferum</i>	177	-52.37 71.98	222	1/5/2003
H3306	<i>Psolidium poriferum</i>	161	-52.39 72.62	302	30/4/2003
H3307	<i>Psolidium poriferum</i>	179	-52.48 71.75	275	1/5/2003
H3308	<i>Psolidium poriferum</i>	174	-52.33 72.68	284	30/4/2003
H3309	<i>Psolidium poriferum</i>	196	-52.57 72.04	292	2/5/2003
H3310	<i>Psolidium poriferum</i>	201	-52.07 71.50	297	2/5/2003
H3311	<i>Psolidium poriferum</i>	216	-51.94 71.29	293	4/5/2003
H3312	<i>Psolidium poriferum</i>	256	-51.77 76.69	259	9/5/2003
H3313	<i>Psolidium poriferum</i>	198	-52.54 72.11	247	2/5/2003
H3314	<i>Psolidium poriferum</i>	191	-52.41 72.05	238	2/5/2003

Reg. No. TMAG	Species	Station SC26	Lat. Long.	Depth m	Date 2003
H3315	<i>Psolidium poriferum</i>	192	-52.37 71.98	222	2/5/2003
H3316	<i>Psolidium poriferum</i>	277	-51.81 76.47	329	10/5/2003
H3317	<i>Psolidium poriferum</i>	158	-52.30 72.69	406	29/4/2003
H3318	<i>Psolidium poriferum</i>	184	-52.53 72.10	247	1/5/2003
H3319	<i>Psolidium poriferum</i>	184	-52.53 72.10	247	1/5/2003
H3320	<i>Psolidium poriferum</i>	153	-52.50 72.88	284	24/4/2003
H3321	<i>Psolidium poriferum</i>	176	-52.41 72.05	237	1/5/2003
H3322	<i>Psolidium poriferum</i>	194	-52.48 71.75	275	2/3/2003
H3431	<i>Echinocucumis ampla</i> sp. nov.	264	-51.87 75.78	779	9/5/2003
H3432	<i>Trachythone muricata</i>	152	-52.49 72.88	283	29/4/2003
H3433	<i>Molpadia violacea</i>	263	-51.80 75.50	628	9/5/2003
H3540	<i>Molpadia violacea</i>	179	-52.48 71.75	275	1/5/2003
H3541	<i>Molpadia violacea</i>	267	-51.82 76.02	472	10/5/2003
H3434	<i>Paracaudina championi</i> sp. nov.	165	-52.34 72.50	462	30/4/2003
H3539	<i>Paracaudina championi</i> sp. nov.	162	-52.44 72.67	287	30/4/2003
H3436	<i>Calcamariina moorea</i> sp. nov.	156	-52.34 72.75	274	29/4/2003
H3544	<i>Calcamariina moorea</i> sp. nov.	251	-51.77 76.70	252	8/5/2003
H3545	<i>Calcamariina moorea</i> sp. nov.	178	-52.42 71.87	263	1/5/2003
H3548	<i>Calcamariina moorea</i> sp. nov.	189	-52.38 72.08	230	2/5/2003
H3437	<i>Paradota weddellensis</i>	176	-52.41 72.05	237	30/4/2003
H3438	<i>Heterocucumis godeffroyi</i>	193	-52.42 71.87	264	2/5/2003
H3439	<i>Psolus ephippifer</i>	179	-52.48 71.75	275	1/5/2003
H3440	<i>Pentactella laevigata</i>	191	-52.41 72.05	238	2/5/2003
H3441	<i>Psolus paradubiosus</i>	191	-52.41 72.05	238	2/5/2003
H3442	<i>Staurocucumis liouvillei</i>	194	-52.48 71.75	275	2/5/2003
H3542	<i>Calcamariina hiberdi</i> sp. nov.	184	-52.53 72.10	247	1/5/2003
H3543	<i>Calcamariina hiberdi</i> sp. nov.	253	-50.91 77.11	341	8/5/2003
H3547	<i>Neopsolidium kerguelensis</i>	203	-52.05 71.40	~290	2/5/2003

Remarks. Table 5 of specimen lots held in TMAG lists specimens from cruise SC26 only, but does not list all specimens taken during SC26 and some from cruises SC46 and SC50. Most specimens from cruises SC46 and SC50 are held in the AAD and are not currently accessible for species identity confirmation and listing here.

Table 6. Kerguelen Islands and HIMI holothuroid species distributed beyond the Kerguelen Plateau.

Kerguelen Plateau	Antarctica	Macquarie Island	Magellanic	Bouvetoya
<i>Pseudostichopus peripatus</i>	<i>Pseudostichopus peripatus</i>			
<i>Pseudostichopus spiculiferus</i>	<i>Pseudostichopus spiculiferus</i>			
¹ <i>Zygothuria lactea</i>	<i>Zygothuria lactea</i>		<i>Zygothuria lactea</i>	
² <i>Clarkiella deichmannae</i>				
<i>Echinocucumis ampla</i>				
<i>Heterocucumis godeffroyi</i>			<i>Heterocucumis godeffroyi</i>	
<i>Calcamariina hibberdi</i>				
<i>Calcamariina moorea</i>				
<i>Pentactella intermedia</i>				
<i>Pentactella laevigata</i>		<i>Pentactella laevigata</i>		
<i>Pentactella serrata</i>				
<i>Neopsolidium kerguelensis</i>				
<i>Pseudopsolus gruui</i>				
<i>Psolidium poriferum</i>				
³ <i>Psolus antarcticus</i>	<i>Psolus antarcticus</i>	<i>Psolus antarcticus</i>	<i>Psolus antarcticus</i>	<i>Psolus antarcticus</i>
<i>Psolus ephippifer</i>				
⁴ <i>Psolus paradubiosus</i>				
<i>Psolus heardi</i>				
<i>Staurocucumis liouvillei</i>	<i>Staurocucumis liouvillei</i>			<i>Staurocucumis liouvillei</i>
<i>Trachythyone lechleri</i>			<i>Trachythyone lechleri</i>	
<i>Trachythyone muricata</i>				
<i>Paracaudina championi</i>				
<i>Molpadia violacea</i>	<i>Molpadia violacea</i>			
<i>Sigmodota contorta</i>	<i>Sigmodota contorta</i>		<i>Sigmodota contorta</i>	<i>Sigmodota contorta</i>
<i>Paradota weddellensis</i>	<i>Paradota weddellensis</i>			

Notes for Table 6:

¹ Gebruk *et al.* (2012) reported a cosmopolitan distribution for *Zygothuria lactea* and a bathymetric range of 694 to 5278 m. There are no specific reports of its occurrence at Bouvetoya Island or Macquarie Island.

² A single Banzare specimen collected from off NE Tasmania was considered by O'Loughlin (2009) to be conspecific.

³ CO1 sequences indicate a species complex (see O'Loughlin *et al.* 2010).

⁴ Six very small CEAMARC psolid specimens from off Terra Adélie were identified as *Psolus paradubiosus* by Mark O'Loughlin and Niki Davey in Paris in 2010 (MNHN catalogue number 2008–5315). We are not confident here of their identification of this sole record of the species from the Antarctic coast.

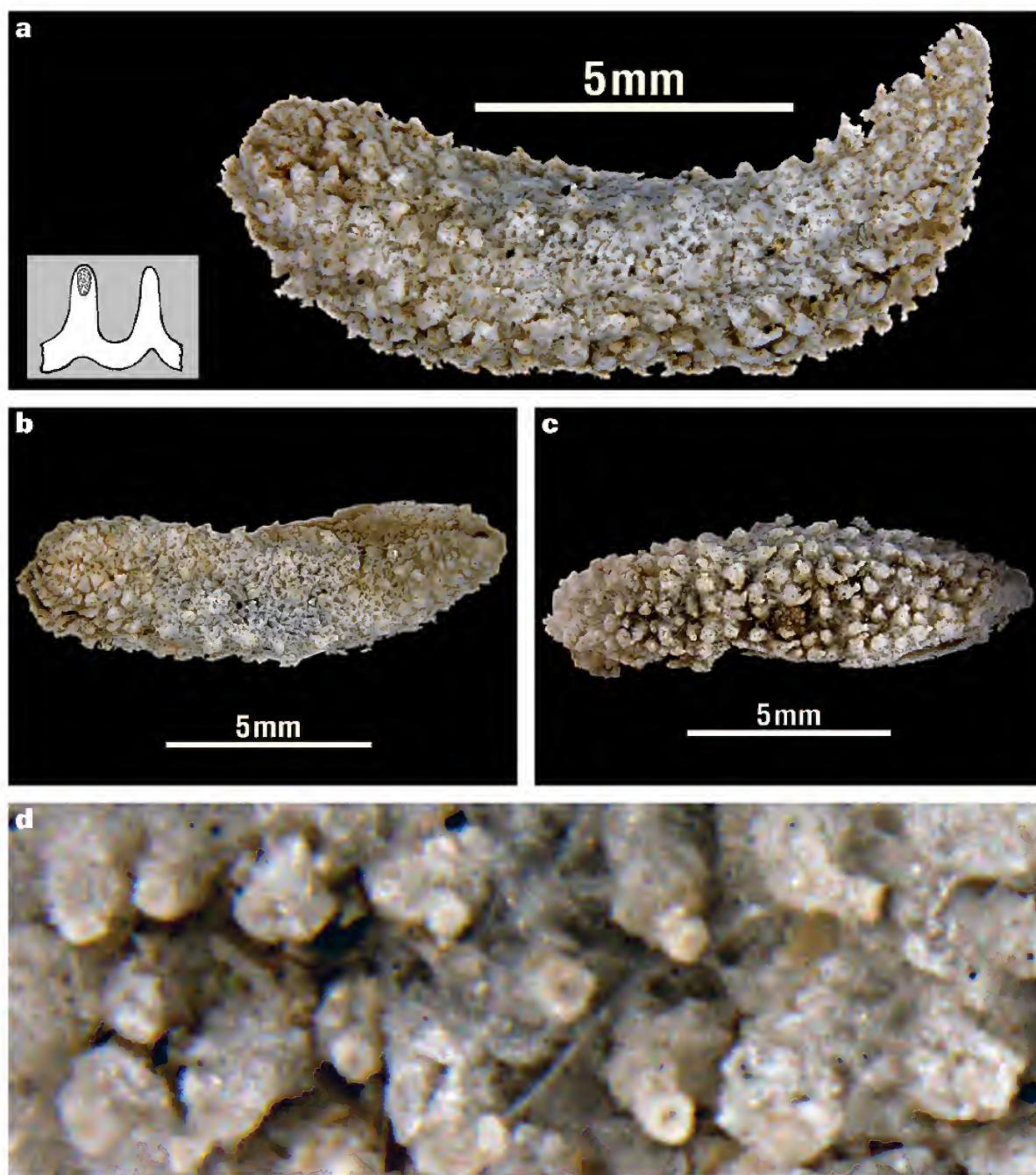


Figure 2. *Calcamariina hibberdi* O'Loughlin & Skarbnik-López sp. nov. holotype photos (NMV F165750). a, left lateral view of holotype with oral end left (insert with drawing of radial (left) and inter-radial plates of the calcareous ring); b, dorsal view of holotype with oral end left; c, ventral view of holotype with oral end left; d, close-up view of some ventral tube feet surmounting calcareous papillae.

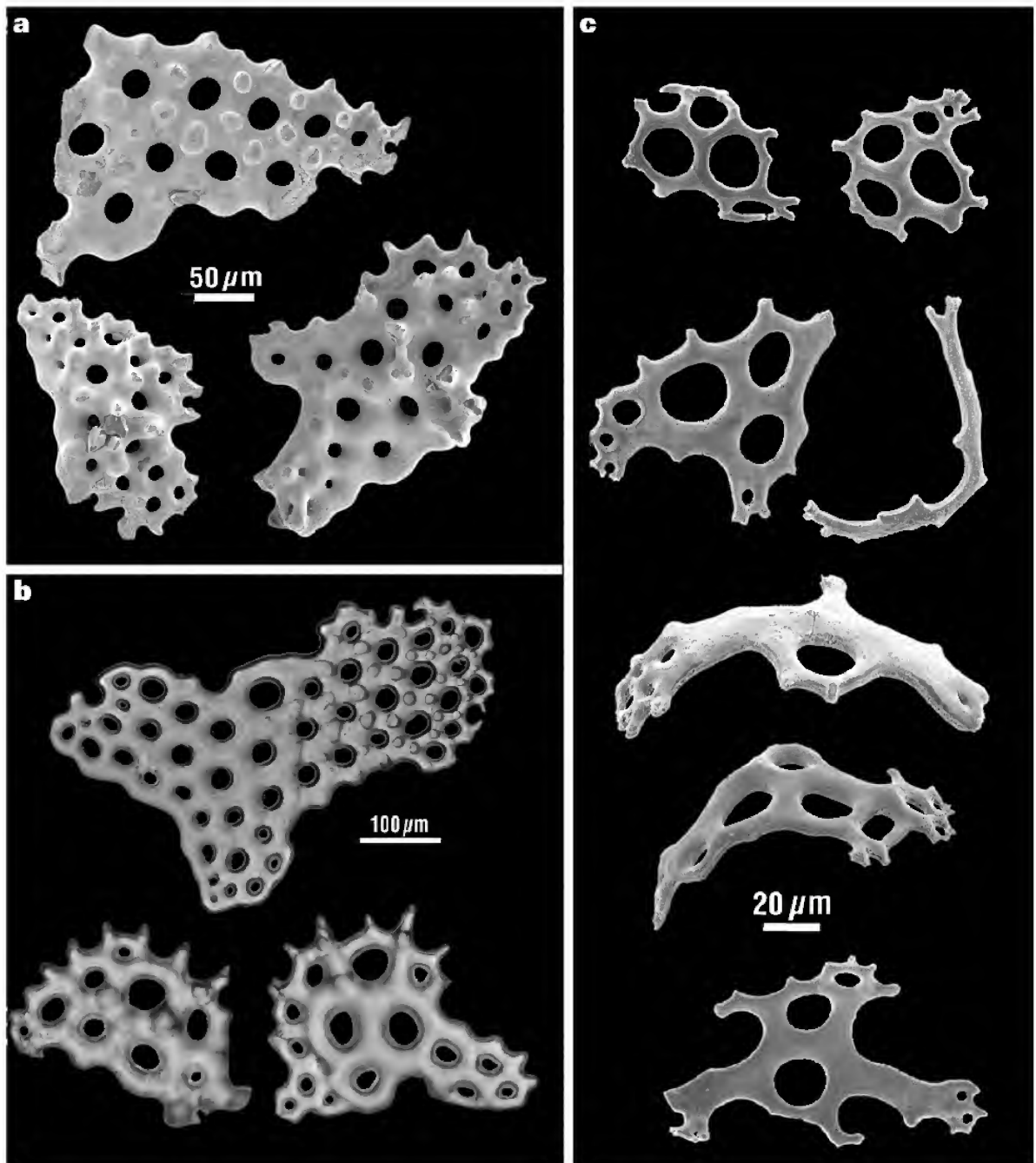


Figure 3. Ossicles from the holotype and a paratype of *Calcamariina hibberdi* O'Loughlin & Skarbnik-López sp. nov. (holotype NMV F165750, paratype TMAG H3542). a, SEM images of variably knobbed and thickened plate fragments from the ventral body wall and papillae, with some marginal spines (from holotype); b, microscope photos of large body wall plate with smooth perforated base and knobbed projecting distal end that has lost its distal spinous edge (top, from holotype; scale bar refers to this ossicle only), and two tube foot/papilla support plates with projecting outer marginal spinous edge (bottom, from paratype; up to about 140 μm long; scale bar does not refer to these ossicles), and; c, SEM images of small perforated, concave plates (top), curved plates, rod and rod-plates from a tentacle (from holotype).

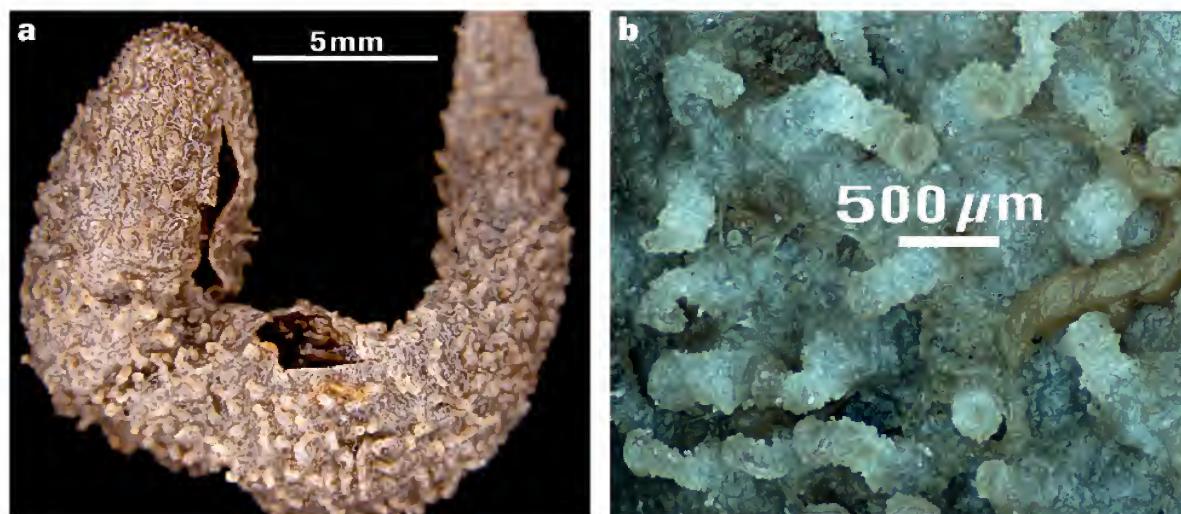


Figure 4. *Calcamariina moorea* O'Loughlin & Skarbnik-López sp. nov. holotype photos (TMAG H3436). a, left lateral view of holotype with oral end left; b, close-up view of some lateral tube feet surmounting calcareous papillae.

***Calcamariina moorea* O'Loughlin & Skarbnik-López sp. nov.**

Zoobank LSID. <http://zoobank.org:act:69F0EDED-FC18-4B0E-8E48-203D73B6831D>

Tables 1–3, 5, 6; figures 1, 4–6.

Cucumaria sp. nov. (HOL 14). Hibberd & Moore, 2009: 119, 146.

Cucumaria kerguelensis (HOL 19). Hibberd & Moore, 2009: 119.

Material examined. Holotype. Southern Ocean, S Kerguelen Plateau, N of Heard Island, Western Plateau, AAD *Southern Champion* cruise 26 haul 156, beam trawl, -52.34 72.75, 274 m, 29 Apr 2003, TMAG H3436 (AAD species code: HOLO 14).

Paratypes (AAD species code: HOLO 14). HIMI, *S Shell Bank*, SC26(251), 252 m, 8 May 2003, TMAG H3544 (1); *Aurora Bank*, SC26(178), 263 m, 1 May 2003, TMAG H3545 (1); *Aurora Bank*, SC26(189), 230 m, 2 May 2003, TMAG H3548 (2); *Shell Bank*, AA92(28), 230–247 m, 30 Jan 1992, NMV F85002 (1); North-east Plateau, HRD93(71S), 514–528 m, 28 Sep 1993, NMV F85003 (1); Heard I., HRD006, 60 m, 3 Oct 1985, NMV F85004 (1).

Description. Body fusiform, up to 29 mm long, curved semi-U-shaped body 16 mm wide/across in lateral view, mid-body diameter 6 mm (holotype TMAG H3436), slightly up-turned rounded oral end, up-turned tapered tail; body dark grey-brown (holotype) to off-white (smaller types), hard, calcareous, covered with low rounded calcareous papillae each with apical terminal tube foot (most evident in larger holotype), tube feet more numerous ventrally than dorsally. Smallest specimens with poorly defined, narrow, ventral, mid-body inter-radii lacking papillae. Lacking anal papillae or scales. Tentacles dendritic, 8 large, 2 ventral small. Calcareous ring cucumariid-like, plates with high anterior radial and inter-radial prolongations, lacking posterior prolongations. Single polian vesicle. Two tufts of un-branched gonad tubules.

Ossicles of body wall and bases of papillae thick rod-plates, fewer narrow, elongate plates, irregular, perforated (frequently with two large parallel and two smaller distal perforations in cross formation centrally), elongate, single-layered, variably with surface and marginal knobs, never marginal spines, rod-plates and plates up to about 350 μ m long. Tube feet with endplates and support rod-plates; endplate diameters variable, up to about 240 μ m; tube foot wall supported by rod-plates, elongate, curved, variable form but typically with two large transverse central perforations and few distal small perforations, plate margin projecting from body wall sometimes with blunt denticulations, rod-plates up to about 220 μ m long.

Distribution. Southern Ocean, S Kerguelen Plateau, *Aurora* and *Shell Banks*, North-east Plateau, *Western Plateau*, Heard I., 60–528 m.

Etymology. Named for Kirrily Moore, Collection Manager for Invertebrate Zoology in TMAG, with recognition of her initial sorting and curation and establishment of a voucher reference collection for the HIMI holothuroids, and with our appreciation of her generous collaboration with loan material and data relevant to our work.

Remarks. *Calcamariina moorea* O'Loughlin & Skarbnik-López sp. nov. is distinguished from *Calcamariina hibberdi* O'Loughlin & Skarbnik-López sp. nov. by the predominance of body wall rod-plates, with paired large central perforations and knobbed only part-margins. In contrast *C. hibberdi* has a predominance of body wall irregular plates that lack large central paired perforations and have part-margin spinous edges.

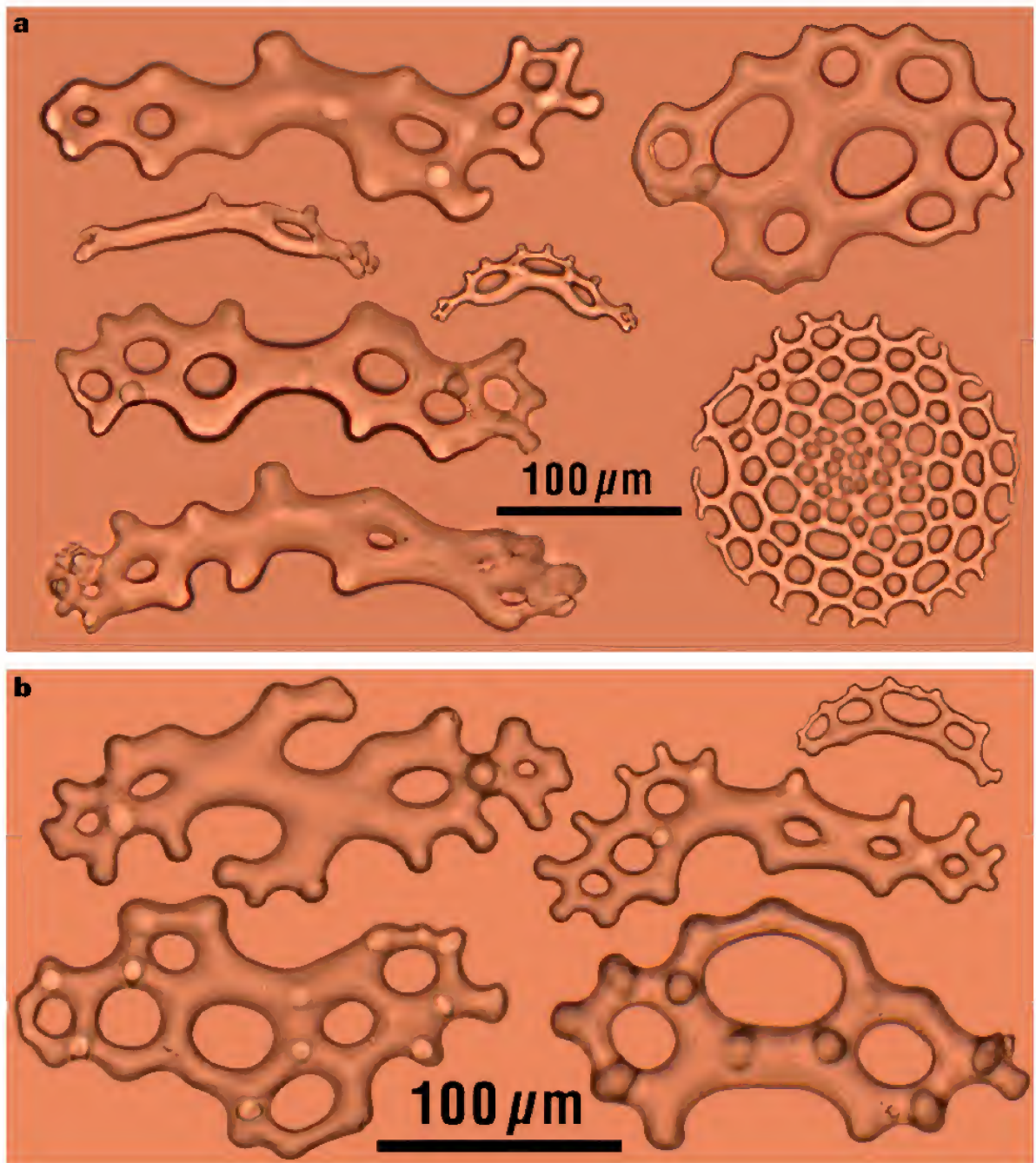


Figure 5. Microscope photos of ossicles from the holotype and a paratype of *Calcamariina moorea* O'Loughlin & Skarbnik-López sp. nov. (holotype TMAG H3436, paratype TMAG H3548). a, endplate, papilla support rods and rod-plates, body wall plate (from holotype); b, tube foot support plates and body wall rod-plates (from paratype).

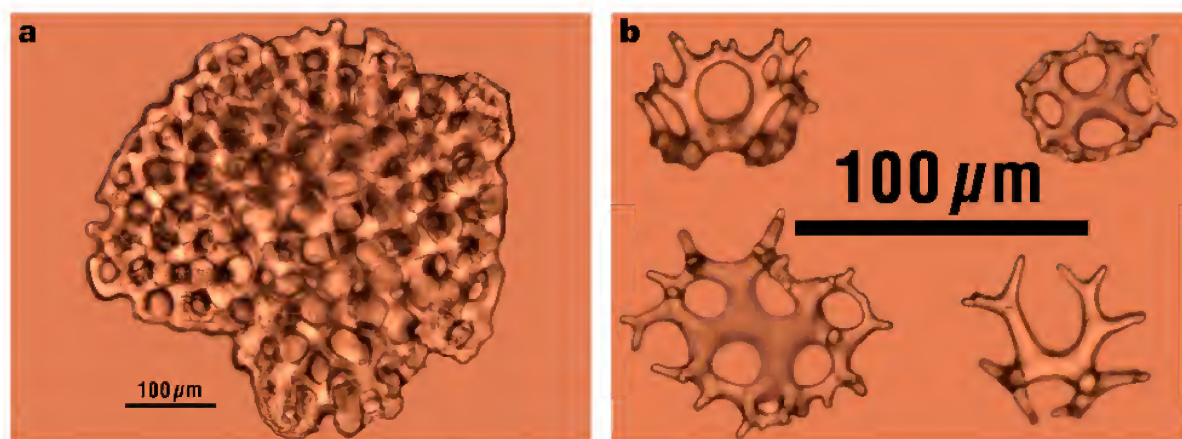


Figure 6. Microscope photos of ossicles from a specimen of *Neopsolidium kerguelensis* (Théel, 1886) (NMV F84997). a, multi-layered ossicle from the body wall; b, cross (bottom right) and cups from the body wall.

We judge that in Hibberd & Moore (2009, page 119) the photo of *Cucumaria* sp. nov. (HOL 14) is a photo of *Calcamariina moorea* O'Loughlin & Skarbnik-López sp. nov. And we judge that the photo of *Cucumaria kerguelensis* (HOL 19) on the same page is also a photo of *C. moorea*. TMAG types have been confirmed by direct observation of TMAG loan material. All were taken by *Southern Champion* cruise 26 and are registered in TMAG. There are probably more specimens of this new species held but not registered and not accessible in the AAD in Kingston.

As noted above for *Calcamaria hibberdi* O'Loughlin & Skarbnik-López sp. nov. the superficially similar species *Neopsolidium kerguelensis* (Théel, 1886) that also occurs on the Kerguelen Plateau is distinguished from the *Calcamariina* species by the former having narrow bare ventral inter-radii, and cups and multi-layered ossicles in the body wall (illustrated here in Figure 6).

Echinocucumis Sars, 1859

Type species (type locality; diagnostic characters). *Echinocucumis hispida* (Barrett, 1857) (Norway; sub-spherical body with vertically up-turned oral and anal ends, body 10 mm wide (width of U-shape), ventral tube feet prominent, dorsal tube feet inconspicuous, plates with single composite marginal spine).

Other assigned species (type localities; diagnostic characters). *Echinocucumis globosa* (Ohshima, 1915) (Kyushu; body spherical, 9.5 mm long, dorsal and ventral tube feet, ossicle spines reduced or absent); *E. hispida* var. *atypica* Deichmann, 1930 (Havana; spines sometimes central on plates, spines more slender and tall than *E. hispida*); *E. kirrilyae* O'Loughlin, 2009 (E Antarctica, Enderby Land; body fusiform, 6 mm long, tube feet ventral only, composite spines dendritic); *E. multipodia* Cherbonnier, 1965 (Cameroon; spherical body, 7 mm long, tube feet around body, scales lack spines); *E. paratypica* Ludwig & Heding, 1935 (Somalia; U-shaped body, 8.5 mm long, long tapered up-turned oral and anal ends); *E. sphaericum* (Sluiter, 1901) (E Indonesia; U-shaped body, 18 mm long, abundant ventral tube feet, numbers of composite spines per scale); *E. tenera* Cherbonnier, 1958 (Sierra Leone; U-shaped body, 25 mm long, dorsal and ventral tube feet).

Diagnosis. Mid-body sub-spherical, tapered non-retractile oral and anal ends, usually upturned; calcareous ring cucumariid-like, lacking posterior prolongations; tentacles 10, digitiform, unequal in size; tube feet sparse or absent, slender, restricted to ambulacra; body invested with large imbricating scales that are single-layered perforated plates, each scale with predominantly one tall spine arising near plate margin.

Remarks. *Echinocucumis* Sars, 1859 has been assigned to the Ypsilothuriidae Heding, 1942 in the order Dactylochirotida Pawson & Fell, 1965. Smirnov (2012) abolished the Dactylochirotida and referred all the included taxa to the Dendrochirotida. Smirnov (2012) assigned the ypsilothuriid genus *Echinocucumis* to the subfamily Cucumariinae Ludwig, 1894 (*sensu* Panning 1949) within the family Cucumariidae Ludwig, 1894. He based his decision on the work of Hansen (1988) who judged that *Echinocucumis* is similar to *Staurocucumis* Ekman, 1927 and *Psolicucumis* Heding, 1934. These two latter genera are assigned to the Cucumariinae. We accept the judgment of Smirnov (2012) based on morphology but anticipate that molecular phylogenetic evidence will challenge many such current assignments.

Echinocucumis ampla O'Loughlin & Skarbnik-López sp. nov.

Zoobank LSID. <http://zoobank.org:act:7147741A-1BFE-48DC-A351-BFB5A53B8539>

Tables 1, 2, 5, 6; figures 1, 7, 8.

Dactylochirotida sp. nov. (HOL 10).—Hibberd & Moore, 2009: 119, 146.

Material examined. Holotype. Southern Ocean, S Kerguelen Plateau, NE Heard Island, North-east Plateau, AAD *Southern Champion* cruise 46 haul 479, beam trawl, -50.68 74.62, 708 m, 30 Jul 2007, NMV F165735 (AAD species code: HOLO 10)

Paratypes. Holotype locality and date, NMV F198492 (2) (UF tissues sequence codes MOL AF663, 664, 665); HIMI, southern *Shell Bank*, SC26(264), -51.87 75.78, 779 m, 9 May 2003, TMAG H3431.

Other material (AAD species code: HOL 10). HIMI, southern *Shell Bank*, SC26(263), -51.80 75.50, 628 m, AAD; SC46(115), -51.81 75.98, 557 m, AAD; North-east Plateau, SC46(471), -50.38 74.54, 970 m, AAD; *Pike Bank*, SC50(016), -51.45 71.84, 756 m, AAD.

Description. Preserved body up to about 65 mm long lateral width (tentacles withdrawn), up to 30 mm high mid-body, tapered anteriorly to partly up-turned rounded oral end, prominent belly mid-body, tapered posteriorly into long up-turned tail; body wall off-white to pale brown, thin, brittle, parchment-like, completely covered with a test of imbricating spined scales, spines more dense ventrally than dorsally. Five inconspicuous anal scales, thick columnar, comprising thick mesh of branched rods, anal scales about 700 μm long. Five elongate, thin anal papillae, walls supported by rod ossicles, papillae up to about 600 μm long. Calcareous ring cucumariid-like, ring narrow, prominent anterior mid-plate radial and inter-radial prolongations, lacking posterior prolongations. Tentacles 10, digitiform, flexible, irregularly long and short. Tube feet absent from the body. Longitudinal muscles cylindrical, thin. Multiple-branching thin gonad tubules.

Body wall ossicles imbricating spined plates; plates irregularly oval in form, single-layered, thick, perforated, perforations predominantly relatively small and spaced, up to about 16 perforations across the diameter, plates up to 1.2 mm long ventrally, slightly smaller dorsally; spines variably near margin of plate to near center, long to short, thick to thin, pillars comprising dendritic branching rods, predominantly one spine per scale, rarely a cluster of up to three, spines rounded and rugose distally with short blunt spinelets; spines dorsally up to 720 μm high (fine spinous distal point frequently lost), up to 200 μm diameter mid-height; spines ventrally more coarse, more than 680 μm high (with fine spinous distal point lost), up to 280 μm diameter mid-height. Distal tail with large thick plates, not multilayered, not closely perforated, small spaced perforations variably present around margin, large central perforation, plates up to 600 μm diameter. Tentacles supported by close, transversely aligned, curved rods; rods irregular in form, variably perforated distally, variably bluntly spinous to short digiform projections laterally, rods up to 300 μm long.

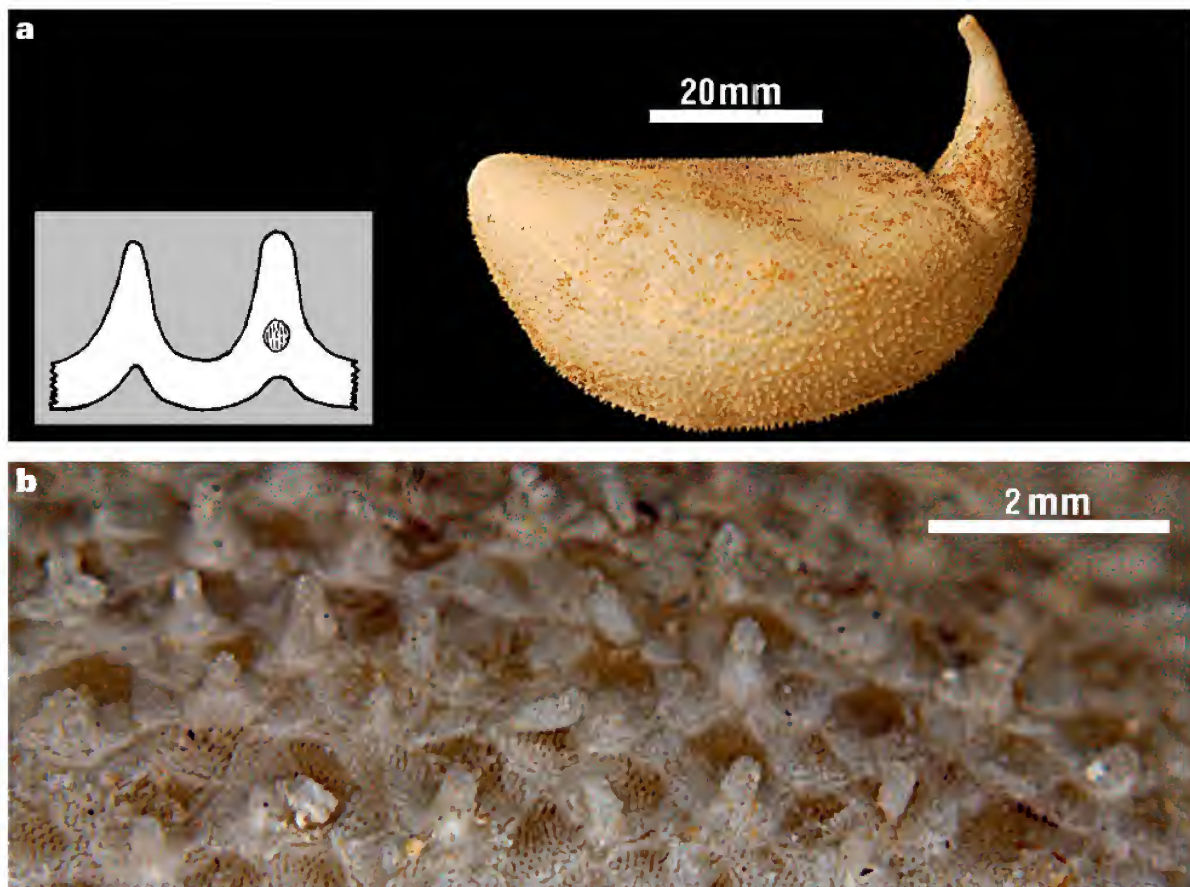


Figure 7. *Echinocucumis ampla* O'Loughlin & Skarbnik-López sp. nov. holotype photos (NMV F165735). a, left lateral view of holotype with oral end left (insert with drawing of radial (right) and inter-radial plates of the calcareous ring); b, imbricating spined plates of the body wall.

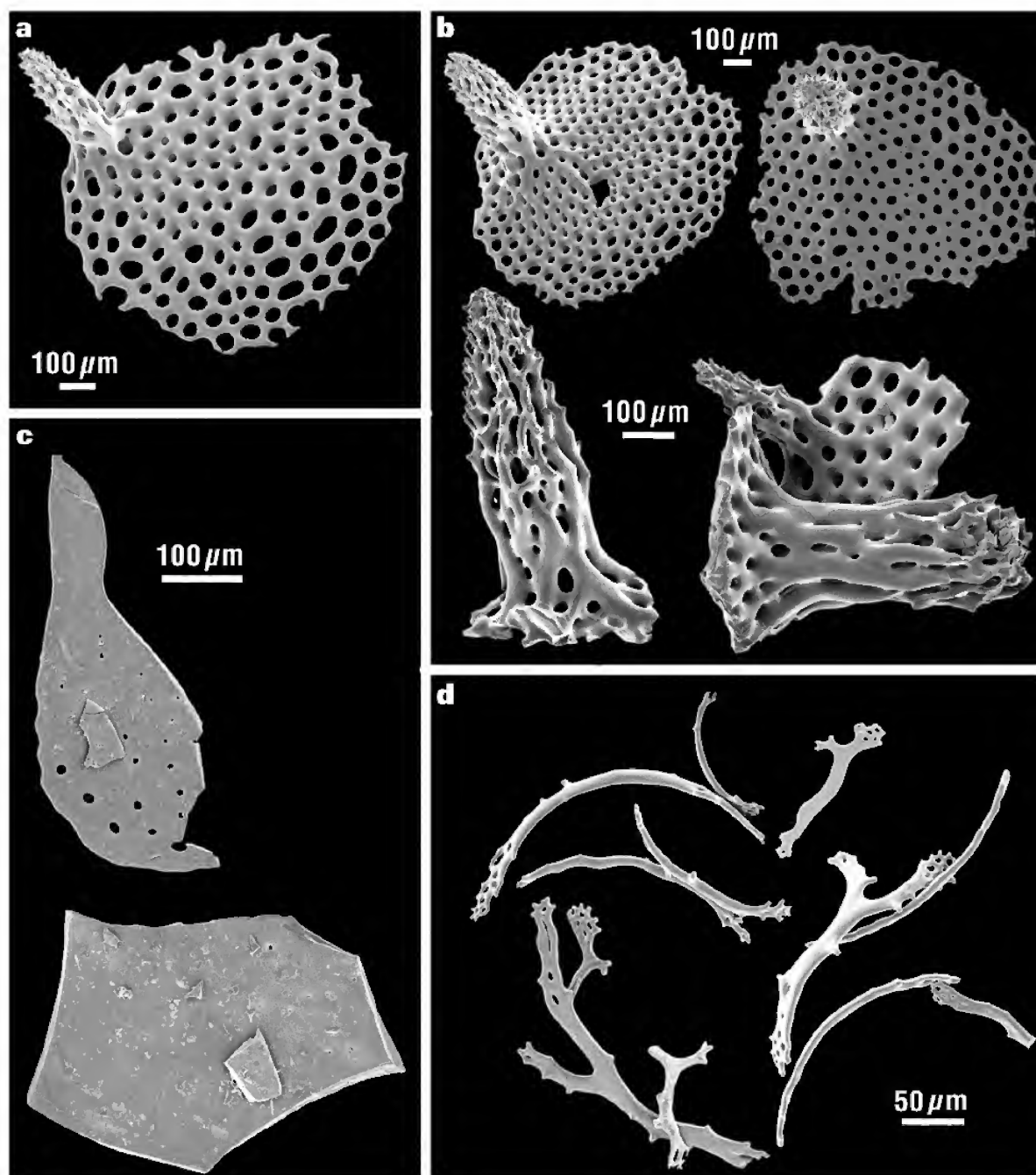


Figure 8. SEM images of ossicles from a paratype of *Echinocucumis ampla* O'Loughlin & Skarbnik-López sp. nov. (NMV F198492). a, spined plate from the mid-dorsal body wall; b, spined plates and spines from the mid-ventral body wall; c, part-perforate plate fragments from the perianal body wall; d, rods from a tentacle.

Distribution. Southern Ocean, S Kerguelen Plateau, N of Heard Island on North-east Plateau, *Pike Bank*, southern *Shell Bank*, 557–970 m.

Etymology. Named from the Latin *ampla* (feminine), meaning large, to indicate the relatively large size of this species.

Remarks. Type specimens were donated to NMV by the AAD. Initial preservation was by freezing, with subsequent transfer to 70% ethanol. In spite of a close examination no tube feet were detected. But in a body wall ossicle sample some small curved thin rods (up to 80 μm across) were found that were probably residual tube foot support rods. And we note the perforation in the upper left scale in Figure 8b that might be a perforation for a tube foot. *Echinocucumis ampla* O'Loughlin & Skarbnik-López sp. nov. is distinguished from all other species of *Echinocucumis* by the combination of: large size; absence of a distinctly tapered up-turned oral end; tube feet not detected; spines variably marginal to central on plates; spines comprising composite, columnar, branched rods. Pawson (1964) referred two specimens from New Zealand to *Echinocucumis hispida* (Barrett, 1857), with some reservations. The larger has a greater curvature length of only 50 mm, distinctly upturned oral and anal ends, single spines arising from the margin only of the scales, and tube feet present. Based on some differences in morphology, and the fact that very few HIMI species have been found north of the Antarctic Convergence, we judge that the New Zealand species is not *E. ampla*. The TMAG paratype has been confirmed by direct observation of TMAG loan material. "Other material" refers to lots that were identified in the AAD by comparison with voucher specimens that were identified by Mark O'Loughlin. These lots are held (unregistered) in the AAD and the determinations not confirmed by Mark O'Loughlin.

Pentactella Verrill, 1876

Pentactella Verrill, 1876a: 68, 69.

Laevocnus O'Loughlin (in O'Loughlin *et al.*, 2014): 46.

Type species. *Pentactella laevigata* Verrill, 1876a, b (type locality Kerguelen Islands; initially monotypic).

Assigned species and occurrences. *Pentactella cornuta* (Cherbonnier, 1941) (Patagonia); *P. intermedia* (Théel, 1886) (HIMI and Kerguelen Is); *P. katrinae* (O'Loughlin in O'Loughlin *et al.*, 2014) (Antarctica, Shag Rock); *P. laevigata* (Verrill, 1876a, b) (HIMI, Kerguelen Is, Macquarie I.); *P. leachmani* (Davey & O'Loughlin in O'Loughlin *et al.*, 2014) (Ross Sea); *P. leoninoides* (Mortensen, 1925) (New Zealand sub-antarctic islands); *P. leonina* (Semper, 1867) (Falkland Is); *L. marionensis* (Théel, 1886) (Marion I.); *P. perrieri* (Ekman, 1927) (Falkland Is, South Georgia); *P. serrata* (Théel, 1886) (HIMI).

Diagnosis (sensu stricto; based on 14 specimens in HIMI lot NMV F85005). Cucumariinid species; body wall thin, firm, not calcareous; body fusiform with posterior rounded taper but not tail; preserved, relaxed body up to 43 mm long (excluding tentacles); 10 equal dendritic tentacles; tube feet on radii only, radial series cross introvert, radial series on relaxed specimens single, slightly zig-zag, spaced, slightly more numerous on three ventral radii; lacking external or internal anal scales; lacking calcareous ring in all specimen sizes; three long, thin polian

vesicles; lacking genital papilla, gonad tubules not branched; two, laterally paired, mid-body, mid-ventral, coelomic brood sacs, with external transverse slit openings, sacs and opening sometimes present; brood juveniles with distinct tentacle crowns may be present in brood sacs, brood juveniles up to 3 mm long. Preserved colour off-white to pale fawn.

Body wall ossicles abundant, oval to elongate, single-layered, perforated plates, typically two large lateral central perforations, typically knobbed centrally, one end of plate tapered and distally spinous, opposite end not tapered, not spinous, plates up to typically 130 μm long; lacking knobbed buttons that do not have any spinous margin. Tube feet with endplates, diameters up to 320 μm , tube foot support ossicles curved perforated plates with outer edge spinous, plate lengths up to 140 μm . Tentacle ossicles thick, perforated plates, irregularly oval to elongate, plates up to 260 μm long; thin, irregular, convex, perforated plates, up to 100 μm across; distally perforate, bent rods, up to 120 μm long; lacking rosettes.

Remarks. Panning (1949) considered *Pentactella* Verrill, 1876 to be a junior synonym of *Stereoderma* Ayres, 1851. Pawson (1964) followed Panning (1949), reporting *Stereoderma laevigata* (Verrill, 1876). Subsequently Panning (1962) referred this species to *Pseudocnus* Panning, 1949. Pawson (1968) followed Panning (1962), reporting *Pseudocnus laevigatus* (Verrill, 1867). In describing the new genus *Laevocnus* O'Loughlin (in O'Loughlin *et al.* 2014) the authors failed to notice that their type species for *Laevocnus*, *Pentactella laevigata* Verrill, 1876, is also the type species for the monotypic *Pentactella* Verrill, 1876. *Pentactella* is here raised out of synonymy with *Stereoderma* and *Pseudocnus*, and *Laevocnus* is an objective synonym of *Pentactella*.

We recognize variations in morphological form amongst the species assigned to *Pentactella*. These variations have been included in the diagnosis for *Laevocnus* (= *Pentactella*) in O'Loughlin *et al.* 2014. The problem of a diagnosis for *Pentactella* is compounded by our recognition of the consistent presence of some knobbed buttons that lack a spinous end in specimens of *Pentactella intermedia* (Théel, 1886). Based on some supportive genetic data *P. intermedia* remains assigned to *Pentactella*. There are to date inadequate genetic data to know what morphological characters are reliable for generic diagnosis. We have thus provided above a *sensu stricto* diagnosis for *Pentactella* that is based on one lot of 14 specimens from the southern Kerguelen Plateau (NMV F85005).

The status of type material for *Pentactella laevigata* Verrill 1876 is uncertain. USNM holds a single specimen with a label: "Type, *Pentactella laevigata* Kidder, Cat. No. 3148, Locality Kerguelen Is, Coll. by Transit of Venus Expedition, Date Dec. 1876, Id. by Verrill". Obviously Verrill was the taxa author, and not the collector Dr. J. H. Kidder. Verrill (1876) gave a collection date as January 1875. This accords with the date of the *US Transit of Venus Expedition* during 1874–1875. The label date (Dec. 1876) may refer to the date of description by Verrill. Pawson (1968) noted "this may be the only extant specimen of the original type series". Verrill provided measurements for only one specimen, and did not indicate more than one type specimen. Pawson (1968) reported on the USNM specimen as a "Co-Type"

(USNM Cat. No. 3148). He judged that this specimen generally matched the description by Verrill (1876). But Pawson noted two anomalies: the presence of a calcareous ring, while Verrill explicitly stated that such plates were absent; and the presence of ventral brood pouches that Verrill did not describe. Our *sensu stricto* diagnosis above matches the descriptions by Verrill (1876) and Pawson (1968), except that we have never observed calcareous ring plates for this species. The presence of ventral brood pouches is rare. Only two specimens of the lot of 14 that we examined have brood pouches.

O'Loughlin (2009) discussed in detail *Pseudocnus intermedia* (Théel, 1886), *Pseudocnus laevigatus* (Verrill, 1876) and *Pseudocnus marionensis* (Théel, 1886), the three species subsequently referred to *Laevocnus* O'Loughlin (in O'Loughlin *et al.* 2014) (= *Pentactella* Verrill, 1876).

O'Loughlin (2009) noted some misleading captions in Théel (1886), that referred to figures of *Cladodactyla crocea* (Lesson, 1830) and *Cucumaria laevigata* (Verrill, 1876). This error misled Massin (1992) who reported *Cladodactyla crocea croceoides* (Vaney, 1908) from Marion Island, with *Cucumaria laevigata* as a junior synonym. This variety was referred to the synonymy of *Cladodactyla crocea* in O'Loughlin *et al.* 2014. Amongst the many holothuroid specimens collected from the Kerguelen Plateau no specimen of *Cladodactyla crocea* has been found.

Family **Psolidae** Burmeister, 1837

Diagnosis. Dendrochirotid species with dorsal and lateral surfaces covered by imbricating scales; ventral sole thin-walled and soft with peripheral tube feet, sometimes also in mid-ventral radial series.

Psolus Oken, 1815

Diagnosis (from Mackenzie & Whitfield 2011). Psolidae with large imbricating or contiguous dorsal and lateral scales; ventrolateral scales at margin clearly demarcated from thin sole that lacks conspicuous scales. Tube feet absent dorsally and laterally, sometimes present orally and anally. Ten dendritic tentacles, eight large and two small ventrally.

Remarks. We note again, for reasons stated in the Introduction, that *Psolus* Oken, 1815 is used provisionally.

Psolus heardi O'Loughlin & Skarbnik-López sp. nov.

Zoobank LSID. <http://zoobank.org:act:FF1FB240-6E7D-44BA-9AF3-B1FADA9EE993>

Psolus sp. nov. (HOL 23).—Hibberd & Moore, 2009: 120,

Tables 1–3, 6; figures 1, 9, 10.

Material examined. Holotype. Southern Ocean, S Kerguelen Plateau, NE Heard Island, NW of *Shell Bank*, ANARE *Aurora Australis*, HRD 93, stn. 71–S, epibenthic sled, -50.72 75.07, 514–528 m, coll. T. Stranks, 28 Sep 1993, NMV F84986.

Paratypes. Holotype locality and date, NMV F198493 (7).

Other material (AAD species code: HOL 23). Southern *Shell Bank*, AAD Southern *Champion* cruise 46 haul 111, beam trawl, -51.81 76.31, 247 m, AAD; southern *Shell Bank*, SC 46(114), -51.81 76.06, 410 m, AAD; southern *Shell Bank*, SC 46(115), -51.81 75.98, 557 m, AAD.

Description. Preserved body up to 12 mm long (excluding tentacles), body up to 5 mm high, body flat ventrally, domed dorsally, lacking oral and anal cones, mouth with anterior orientation, dorsal and lateral body with conspicuous imbricating scales, lacking tube feet, ventro-lateral scales projecting slightly over a soft sole. Discrete sole, lacking scales, peripheral series of large tube feet, series not continuous anteriorly, rare mid-ventral tube feet. Tentacles dendritic, 10, ventral pair small. Calcareous ring solid, cucumariid-like, digitiform anterior projection and deep posterior notch on both radial and inter-radial plates, lacking posterior prolongations. Longitudinal muscles narrow, flat. Gonad comprises 2 tufts of sac-like tubules, one on each side of the dorsal mesentery, hermaphrodite, coelomic brood-protecting.

Dorsal and lateral ossicles imbricating scales and cups; scales irregularly oval, up to about 1 mm long, scales are perforated plates with mesh-like secondary layering, finely spinous dorsal surface layer; cups irregular, shallow to deep, predominantly four perforations in cross form, sometimes small corner perforations, cups variably knobbed or with short digitiform projections, some incipiently bridged, cups typically 140 μ m long. Sole with irregular, marginally knobbed, perforated, shallow, concave plates, up to about 8 perforations, up to about 360 μ m long; plates inter-grade with shallow cups, similar to dorsal cups, predominantly 4 large perforations, sometimes smaller corner ones, margin knobbed, some secondary knobs and developments, cups about 140 μ m long. Tentacle ossicles thick, perforated rods and plates, irregular, curved, variably knobbed and digitate margins, some surface knobs, plates and rods up to 320 μ m long; small thin curved plates, about 50 μ m long; rare fine irregular crosses, about 50 μ m long; small rosette-like ossicles, about 100 μ m long.

Distribution. Southern Ocean, Kerguelen Plateau, NE Heard Island, *Shell Bank*, 247–557 m,

Etymology. Named *heardi* with reference to Heard Island.

Remarks. We provisionally assign this new species to the currently suppressed *Psolus* Oken, 1815, pending an appeal to the ICZN (see Introduction). While *Psolus heardi* O'Loughlin & Skarbnik-López sp. nov. satisfies the general diagnostic criteria for referral to *Psolus*, we are aware that emerging phylogenetic data do not support the family Psolidae and provide evidence that the genera *Psolus* Oken and *Psolidium* Ludwig, 1887 are polyphyletic (Gustav Paulay pers. comm.). *Psolus heardi* O'Loughlin & Skarbnik-López sp. nov. differs from all other *Psolus* species by having a combination of: coelomic brood-protecting habit; poorly defined ventro-lateral margin overlapping the sole; dorsal scales that are single-layered with mesh-like secondary layering that has fine dorsal surface spines; shallow, irregular, marginally knobbed cups that are similar dorsally and in sole. "Other material" refers to lots that were identified in the AAD by comparison with voucher specimens that were identified by Mark O'Loughlin. These lots are held (unregistered) in the AAD and the determinations not confirmed by Mark O'Loughlin.

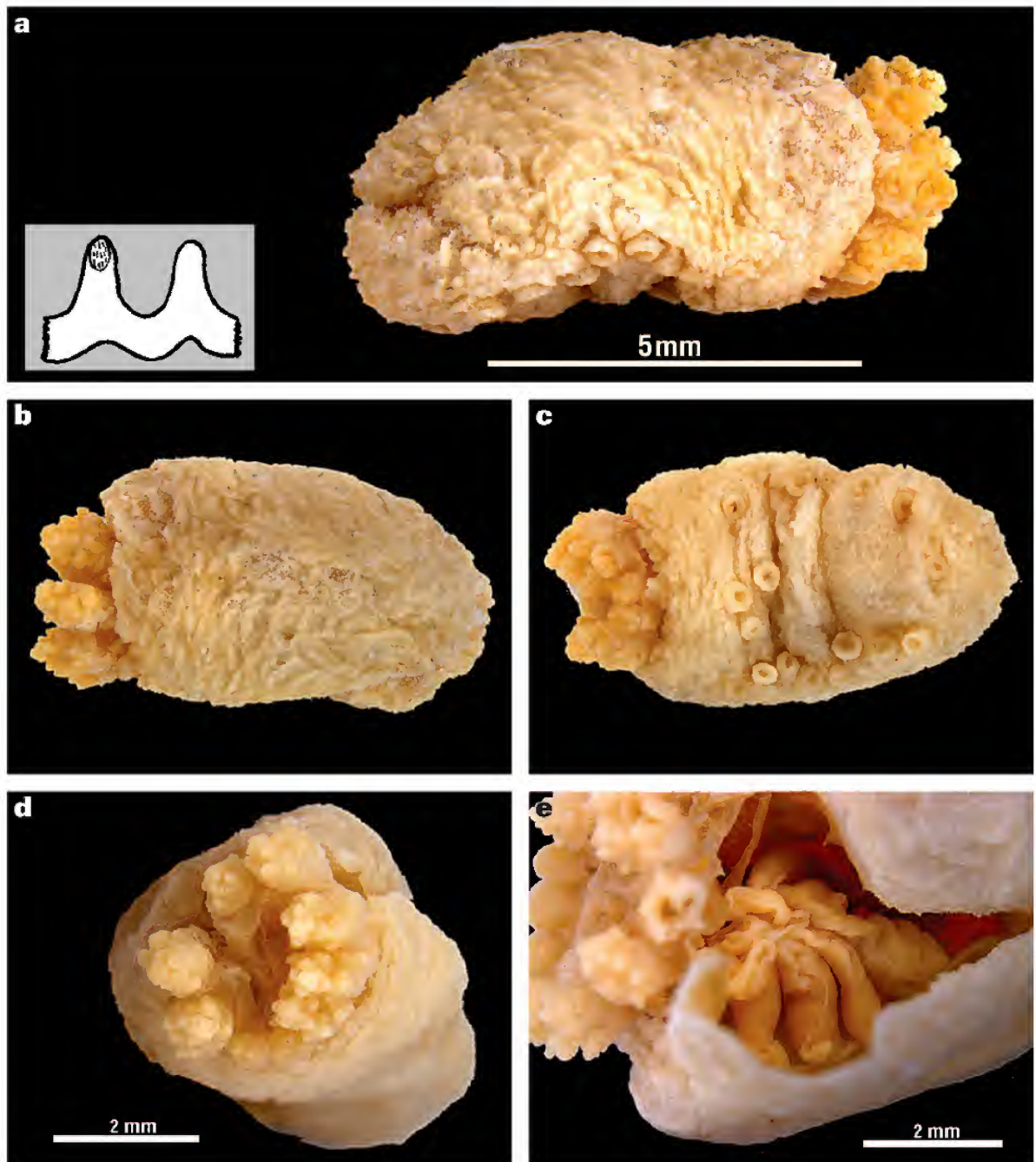


Figure 9. *Psolus heardi* O'Loughlin & Skarbnik-López sp. nov. photos (a–d of holotype NMV F84986; e of paratype NMV F198493). a, lateral view with oral end right, ventro-lateral scales slightly overhang sole (insert with drawing of radial (left) and inter-radial plates of the calcareous ring); b, dorsal view with oral end left; c, ventral view, weakly delineated sole with peripheral tube feet; d, tentacles with two small ventral ones (bottom); e, cluster of gonad tubules.

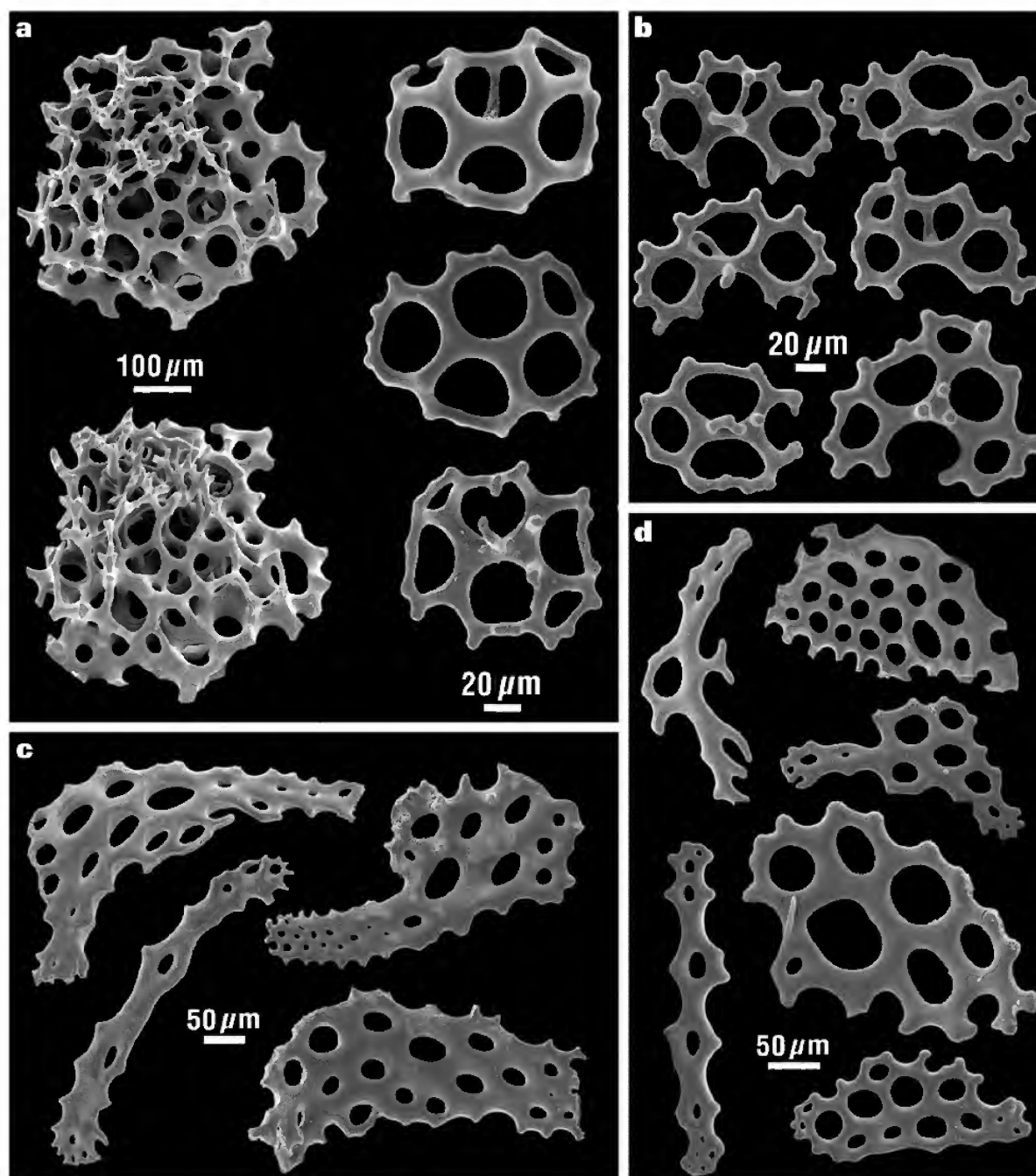


Figure 10. SEM images of ossicles from a paratype of *Psolus heardi* O'Loughlin & Skarbnik-López sp. nov. (NMV F198493). a, dorsal mid-body scales (left) and shallow cups (right); b, shallow cups from the sole; c, curved perforated rod and plates from a tentacle; d, tube foot half endplate fragment (top right), perforated rods (left), and curved knobbed perforated plates (right lower two-thirds).

Order **Molpadida** Haeckel, 1896

Diagnosis (from O'Loughlin et al. 2011). Tentacles 15, digitate; body stout, lacking tube feet, usually with an evident tail; anal papillae, tentacle ampullae and respiratory trees present; ossicles may include tables, cups, rods, perforated plates and modified anchors; phosphatic bodies often present.

Family **Caudinidae** Heding, 1931

Diagnosis (from O'Loughlin et al. 2011). Tentacles without a terminal digit, and with one or two pairs of lateral digits; tail sometimes inconspicuous; ossicles may include large tables, crossed cups, perforated plates and irregular rods; phosphatic bodies usually absent.

Paracaudina Heding, 1932

Remarks. O'Loughlin et al. (2011) provided a comprehensive diagnosis of *Paracaudina* Heding, 1932, listed all assigned species, and included a key to the Australian and New Zealand species. In a subsequent paper Davey & O'Loughlin (2013) discussed the caudinid species of New Zealand, described two

additional species of *Paracaudina*, and provided a key to the New Zealand caudinid species.

Paracaudina championi O'Loughlin & Skarbnik-López sp. nov.

Zoobank LSID. <http://zoobank.org:act:86F7DB87-F210-4732-9A77-2FC03915134B>

Tables 1–3, 5, 6; figures 1, 11–13.

Molpadiidae sp. nov. (HOL 11).—Hibberd & Moore, 2009: 119, 145.

Material examined. Holotype. Southern Ocean, S Kerguelen Plateau, NE Heard Island, North-east Plateau, AAD *Southern Champion* cruise 46 haul 479, beam trawl, -50.67 74.62, 708 m, 30 Jul 2007, NMV F165736 (UF tissue sequence code MOL AF666) (AAD species code: HOL 11).

Paratypes (AAD species code: HOL 11). HIMI, Western Plateau, SC26(162), -52.44 72.67, 287 m, 30 Apr 2003, TMAG H3539 (3); SC26(165), -52.34 72.50, 462 m, 30 Apr 2003, TMAG H3434 (1).

Other material (AAD species code: HOL 11). Southern *Shell Bank*, SC26(264), -51.87 75.78, 779 m, AAD; *Shell Bank* MR, SC46(125), -51.69 76.19, 234 m, AAD; North-east Plateau, SC46(473), -50.48 74.60, 905 m, AAD; SC46(474), -50.46 74.79, 942 m, AAD.



Figure 11. *Paracaudina championi* O'Loughlin & Skarbnik-López sp. nov. holotype photo of lateral view (oral end left) (insert with drawing of radial (left) and inter-radial plates of the calcareous ring) (NMV F165736).

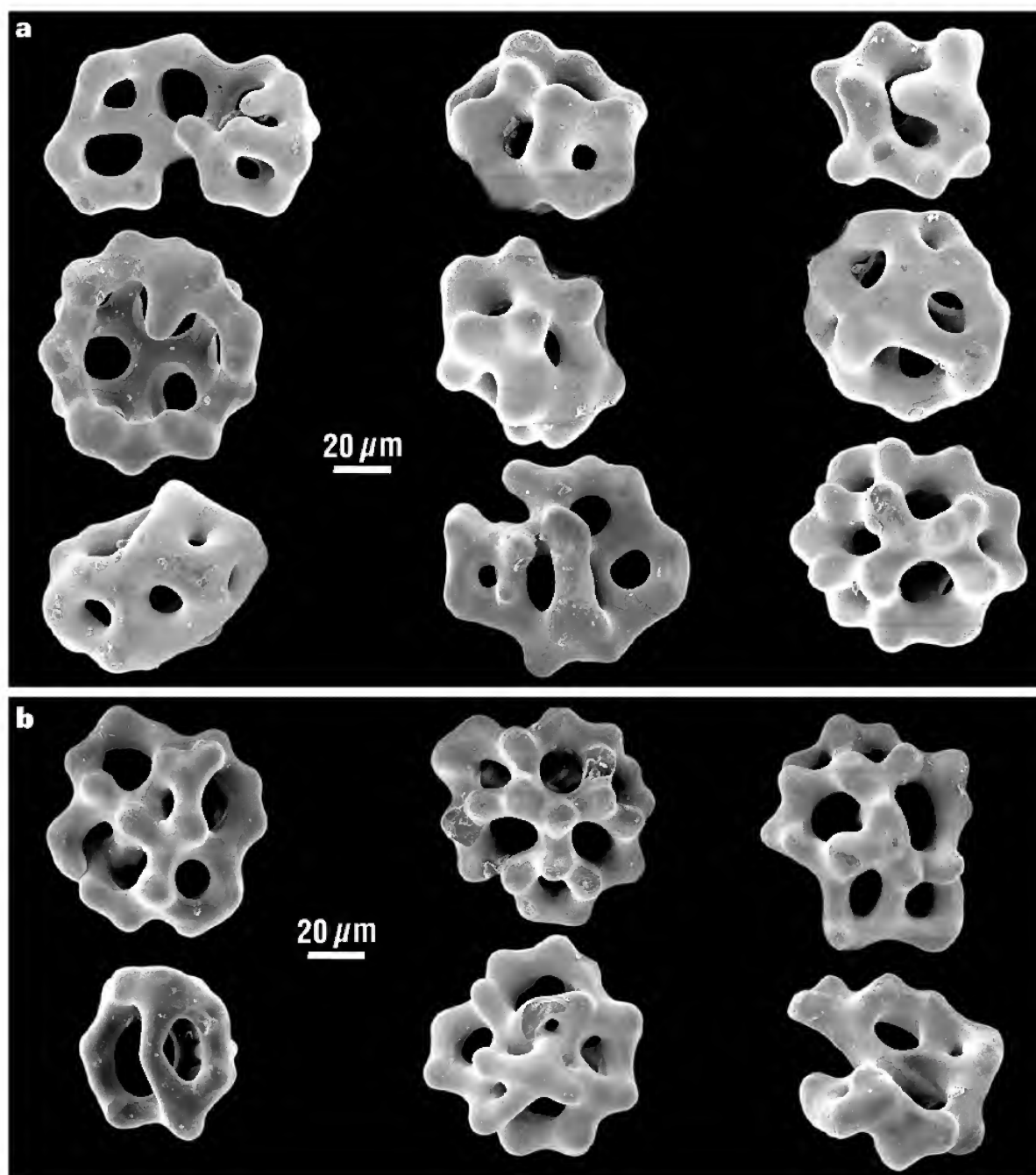


Figure 12. SEM images of ossicles from the holotype of *Paracaudina championi* O'Loughlin & Skarbnik-López sp. nov. (NMV F165736). a, irregular knobbed cup-like ossicles from the mid-body wall, with cross base evident mid-left and bottom right; b, irregular knobbed cup-like ossicles from the caudal body wall, with cross base evident upper middle and right.

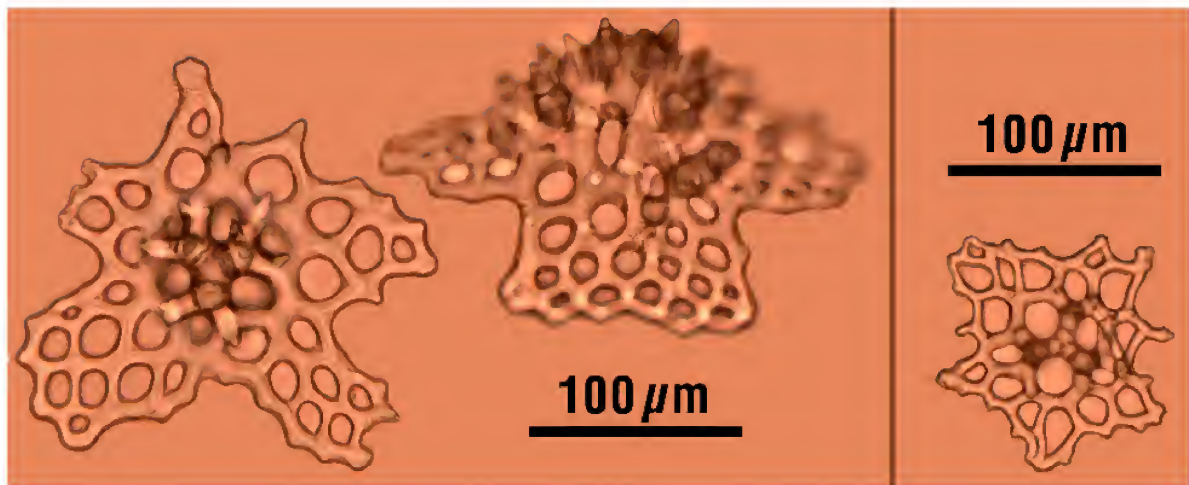


Figure 13. Microscope photos of table ossicles from the peri-anal body wall of paratypes of *Paracaudina championi* O'Loughlin & Skarbnik-López sp. nov. Two left tables from large specimen (TMAG H3434); single right table from small specimen (TMAG H3539).

Description. Preserved body up to 115 mm long (strongly contracted), tapering posterior body and tail 40 mm long, mid-body up to 30 mm diameter; body wall thick, leathery, wrinkled with transverse creases, pale brown to off-white to pale grey in colour; body form cylindrical, slight taper to blunt oral end, about one third of the body tapered to thin posterior tail (end of tail missing in holotype), tail not discretely delineated. Lacking anal scales or papillae. Tentacles 15, digitiform, lacking terminal digit or digits. Calcareous ring solid, plates fused; radial plates with two anterior projections, one with longitudinal muscle attachment and small anterior notch, separated by a bigger notch from the second lateral anterior projection, plates with tapered posterior projection with small bifid notch posteriorly; inter-radial plates with tapered anterior projection, wide rounded posterior indentation. Tentacle ampullae variable in length, up to twice the height of the ring in length. Single polian vesicle, tubular, long. Longitudinal muscles broad, flat, each divided along mid-line by narrow gap. Long, thin, unbranched gonad tubules.

Mid-body and caudal, but not peri-anal, ossicles are similar; some but not most are fairly regular, thick, knobbed cups with a basal distally-knobbed cross; most have no regular form and are thick, knobbed, often three-dimensional, and very irregular; ossicles predominantly up to 40 μm long. Peri-anal body wall with irregular knobbed cups and irregular thick tables; knobbed cups as in mid-body wall; tables in smaller specimens with predominantly 3-pillar spires, one cross-bridge, few lateral blunt spines, 3 paired blunt spines apically, spires on tables in larger specimens complex with numerous distal blunt spines, spires up to about 170 μm high; table discs indented centrally, raised marginally, irregular angular margins, predominantly 6 central perforations, 2 outer circles of irregular perforations, discs up to about 180 μm across in small specimens, up to about 250 μm across in large specimens.

Distribution. Southern Ocean, Kerguelen Plateau, N of Heard Island on North-east Plateau, *Shell Bank*, Western Plateau, 234–942 m.

Etymology. Named *championi* for the fishing trawler *Southern Champion* that was commissioned by the AAD to serve this research expedition.

Remarks. The holotype was donated to NMV by the AAD. Initial preservation was by freezing, with subsequent transfer to 70% ethanol. The presence of peri-anal 3-pillared, large, thick tables is a significant morphological addition to the diagnostic characters of *Paracaudina* Heding, 1932 that was provided by O'Loughlin *et al.* (2011). Caudal ossicles in *Paracaudina* specimens have been discussed and illustrated by O'Loughlin *et al.* (2011). No tables were observed in the mid-body wall or caudal region. In reporting on the New Zealand Caudinidae species, Davey & O'Loughlin (2013) discussed *Hedingia* Deichmann, 1938, and the New Zealand occurrence of *Hedingia albicans* (Théel, 1886). In *H. albicans* there are abundant three-pillared tables with irregular discs in the caudal region, and rarely in the mid-body wall. *Hedingia* species lack thick, knobbed cup ossicles. The new caudinid species described here has the characteristic paracaudinid thick, knobbed cup ossicles throughout the body wall, but also has the characteristic tables of *Hedingia* in the posterior caudal region. We have provisionally assigned our new species to *Paracaudina* and await the evidence of molecular phylogenetic data for generic confirmation.

Apart from the significant diagnostic difference of presence or absence of caudal tables, *Paracaudina championi* O'Loughlin & Skarbnik-López sp. nov. is similar to *Paracaudina alta* Davey & O'Loughlin, 2013 with its very irregular ossicle forms. But the thick, knobbed cup ossicles are quite dissimilar to the more regular ossicles of all other species of *Paracaudina*. The illustration of *P. alta* body form (Fig. 1B)

in Davey & O'Loughlin (2013) indicates that most of the body is cylindrical with a relatively short discrete tail, whereas for *Paracaudina championi* about one third of the body exhibits a long caudal taper. Body wall ossicles for *P. alta* are illustrated by Davey & O'Loughlin (2013) and also by O'Loughlin *et al.* (2011) for the earlier conspecific *Paracaudina* species. We judge that amongst the very irregular ossicles of both species a basal distally-knobbed cross is sometimes evident amongst the ossicles of *P. championi* but not amongst those of *P. alta*. Their respective occurrences north and south of the Antarctic Convergence, and considerable geographical separation, also discourage us from thinking that they are conspecific. We await molecular phylogenetic data for insight into these relationships of current *Paracaudina* species. TMAG paratypes have been confirmed by direct observation of TMAG loan material. "Other material" refers to lots that were identified in the AAD by comparison with voucher specimens that were identified by Mark O'Loughlin. These lots are held (unregistered) in the AAD and the determinations not confirmed by Mark O'Loughlin.

Family Molpadiidae Müller, 1850

Diagnosis (Pawson 1977). Tentacles claw shaped or with terminal digits and few small lateral digits. Tentacle ampullae long or reduced. Spicules derived from tri-radiate tables with three-pillared spire. Tail with tables with round to oblong disc or long fusiform rods. Phosphatic deposits often present.

Molpadia Cuvier, 1817

Diagnosis (Pawson 1977). Calcareous deposits include tables, anchors, and rosettes of racquet-shaped plates and large fusiform rods in various combinations. Tail deposits tables or fusiform rods. Phosphatic deposits present or absent.

Type species. *Molpadia musculus* Risso, 1826 (type locality Mediterranean Sea).

Molpadia violacea Studer, 1876

Tables 1–6; figures 1, 14, 15 e, f.

Molpadia violacea Studer, 1876: 464.—Pawson, 1963: 15, pl. 3, figs 4–8.—1965: 12.

Trochostoma violaceum.—Théel, 1886: 42–43, pl. 2, fig. 4, pl. 11, fig. 1.—Lampert, 1889: 842.—Ludwig & Heding, 1935: 144.—Perrier, 1905: 65–66.

Haplodactyla violacea.—Heding, 1931: 280.

Eumolpadia violacea.—Heding, 1935: 42, text fig. 8, figs 7–10; pl. 5 fig. 10; pl. 7, fig. 3; pl. 8, fig. 4.—Ludwig & Heding, 1935: 144–145, text fig. 11.—Cherbonnier & Guille, 1975: 609.

Molpadia musculus Risso, 1826 (Antarctic).—O'Loughlin *et al.*, 2009: table 1.—O'Loughlin *et al.*, 2010: 269(6), tables 1, 2, 4, fig. 2 (non *Molpadia musculus* Risso, 1826).

Molpadia musculus (HOL 12).—Hibberd & Moore, 2014: 42, 119, 145 (non *Molpadia musculus* Risso, 1826).

Material examined. Holotype. Southern Ocean, N Kerguelen Plateau, SMS *Gazelle* 1874, Kerguelen Islands, 183 m, ZMB 2070.

Other material (AAD species code: HOL 12). HIMI, *Aurora Bank*, SC26(179), -52.48 71.75, 275 m, 1 May 2003, TMAG H3540 (1);

SC26(193), -52.42 71.87, 264 m, AAD; Southern *Shell Bank*, SC26(263), -51.80 75.50, 628 m, TMAG H3433 (4); SC26(267), -51.82 76.02, 472 m, 10 May 2003, TMAG H3541 (1); *Shell Bank* MR, SC46(128), -51.55 75.76, 337 m, AAD; off Heard I., AD67(40), -52.95 73.34, 112 m, NMV F76842 (1); *Pike Bank*, SC50(10), -51.31 71.77, 273 m, NMV F165737 (1) (UF tissue sequence code MOL AF667).

Eastern Antarctica, Prydz Bay, AA91(84), -68.05 73.18, 680 m, NMV F71992 (1).

Western Antarctica, South Shetland Islands, AMLR 2003(71), -62.44 -61.14, 138 m, NMV F104825 (1) (UF tissue sequence code MOL AF574); South Shetland Islands, LI-AGT-3, -62.40 -61.76, 556 m, NMV F168644 (3) (UF tissue sequence code MOL AF809); South Orkney Islands, US AMLR 2009(104), -63.23 -59.46, 757–783 m, NMV F169293 (4); South Orkney Islands, US AMLR 2009(41–42), -61.82 -46.19, 450–461 m, NMV F169294 (1); South Orkney Islands, US AMLR 2009(21), -61.06 -42.84, 422–428 m, NMV F169295 (1); off Hugo I., -64.74 -65.48, 684–705 m, NMV F169353 (1); South Shetland Islands, US AMLR 2012(247), -62.38 -61.42, 344 m, NMV F193760 (5).

Description. Body up to 145 mm long, up to 25 mm diameter (preserved, NMV F169293, South Shetland Is), body form cylindrical mid-body with short anterior taper to blunt rounded end, posterior taper to short discrete thin tail, about 10% of body length, body wall firm, leathery. Tentacles 15, digitiform, each with single terminal digit. Calcareous ring solid, plates fused, radials wider than inter-radials, radials with two anterior lateral rounded projections, one with longitudinal muscle attachment and anterior notch with anterior ends of notch incurved and almost closed, tapered posterior prolongation with small bifid posterior notch; inter-radials with pointed anterior projection, broad rounded posterior indentation. Length of tentacle ampullae more than twice the height of the ring. Single polian vesicle tubular, long. Long stone canal with spiral form; madreporite attached to body wall. Longitudinal muscles broad, flat, each divided along mid-line by wide gap. Gonad tubules branched.

Ossicles tables and fusiform rods, tables and rods in main body wall, rods only caudally, in larger specimens main body tables and fusiform rods variably to completely phosphatised; tri-radiate table discs with predominantly three perforations, often a few more than three, discs frequently irregular, disc margin smooth or frequently with short to long rod-like projections from margin distal to perforations, discs variable in size, up to 190 μ m across (excluding rod-like extensions from margin), solid columnar spires with blunt distal spines, spires about 70 μ m high, tables phosphatize into reddish-orange bodies; long fusiform rods in mid-body and tail, rods widened centrally with elongate perforation with irregular thin bridging rods creating 2–6 irregular perforations, predominantly 3, rods variable in length, mid-body rods up to up to 1300 μ m long, only rods in mid-body phosphatize, caudal fusiform rods smaller than in mid-body, up to 900 μ m long, mid-body and caudal fusiform rods never with solid spire similar to tables. Inconspicuous anal scales in peri-anal body wall, irregular columnar form, comprise a dense rod network, scales up to about 360 μ m long. Anchors or racquet-shaped plates not observed. Ossicles phosphatising to red, orange and yellow irregularly oval bodies or clusters of granules, sizes vary.

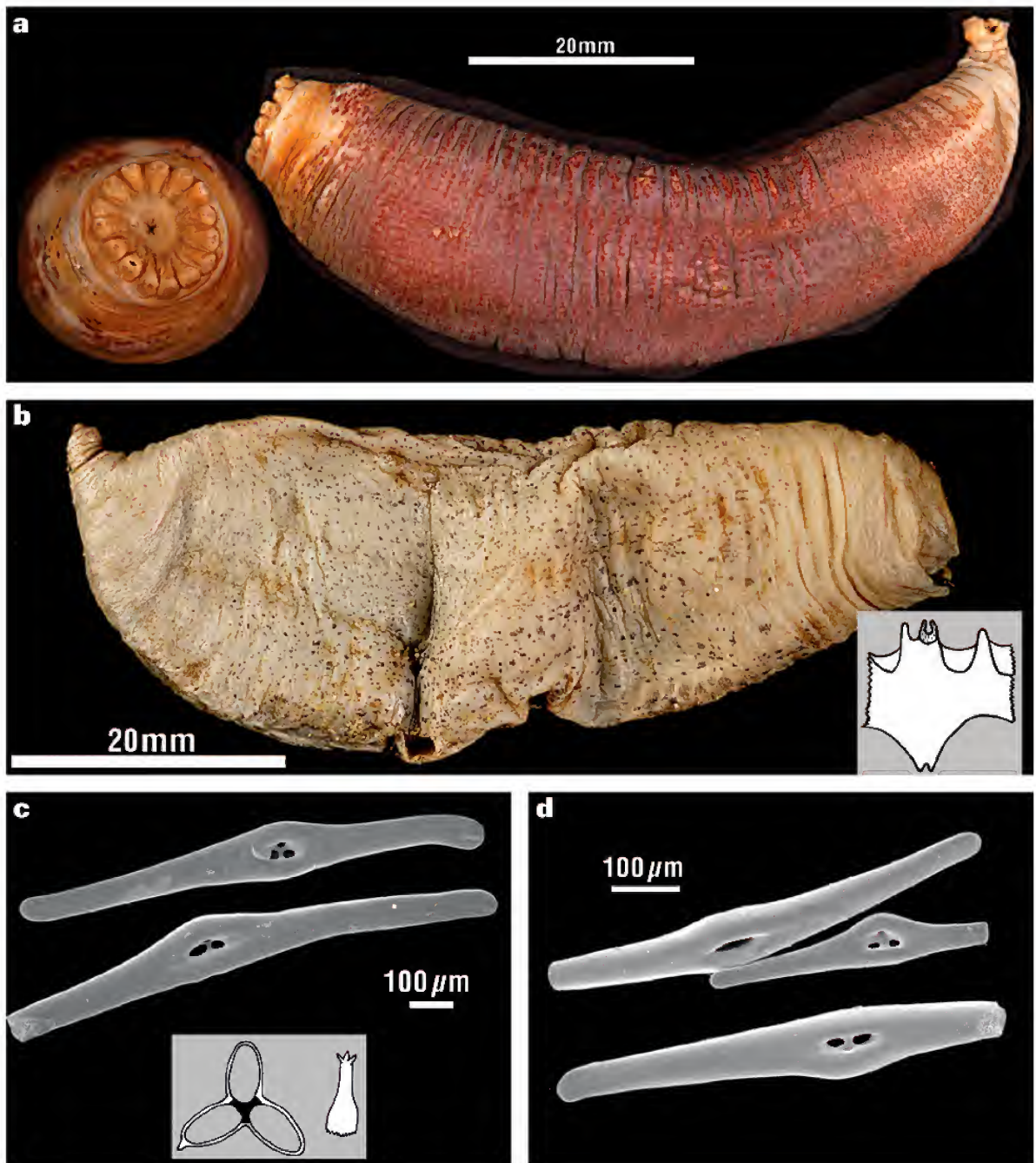


Figure 14. *Molpadia violacea* Studer, 1876 photos and SEM ossicle images. a, left lateral view of holotype (oral end left) (ZMB 2070) (bottom left insert with photo of tentacles); b, right lateral view of HIMI specimen of *Molpadia violacea* (NMV F165737) (insert with drawing of radial (left) and inter-radial plates of the calcareous ring); c, d, SEM images of fusiform rod ossicles from HIMI specimen of *Molpadia violacea* (NMV F165737); c, from mid-body wall (insert with drawings of table disc and spire); d, from caudal body wall.

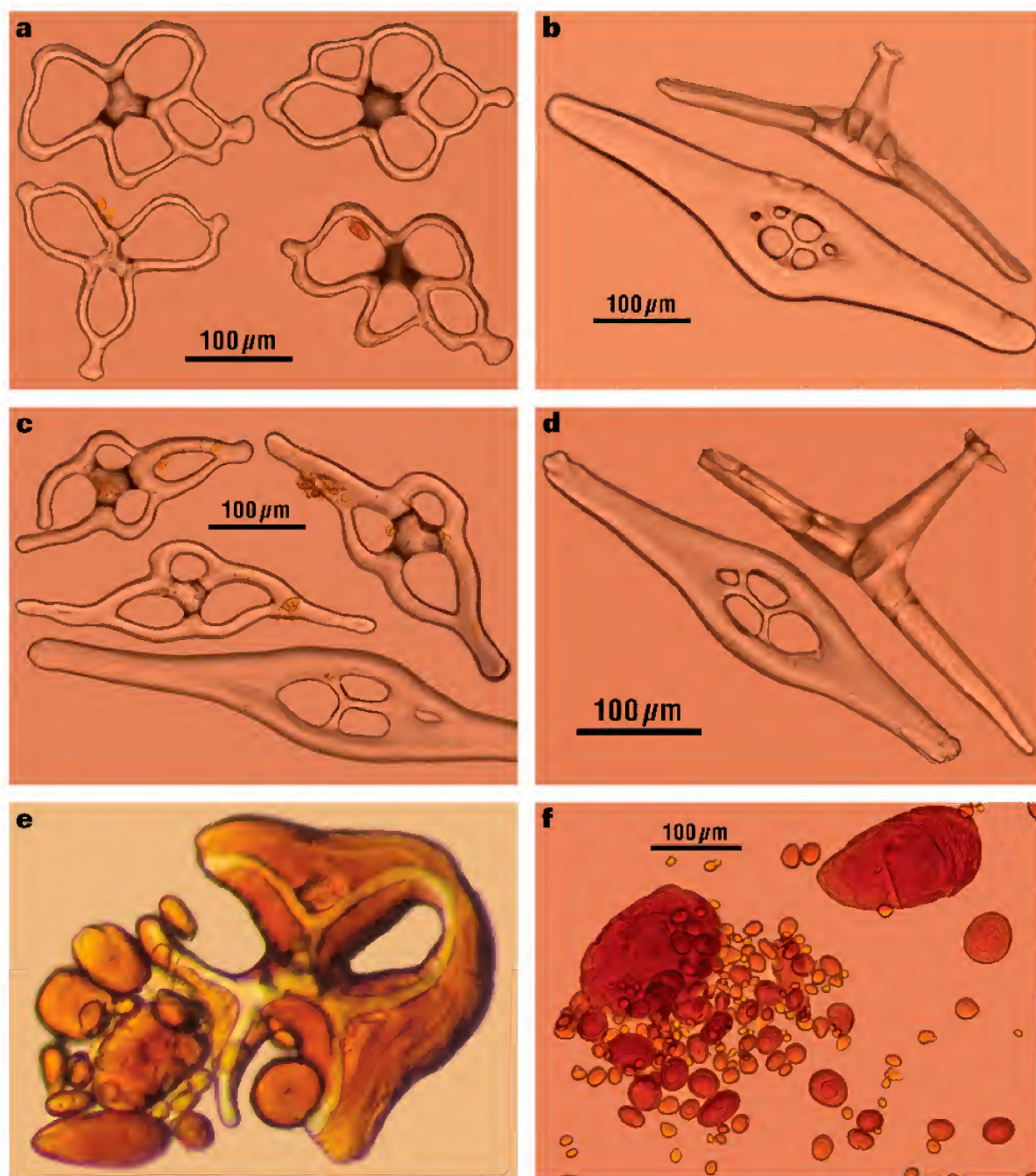


Figure 15. Microscope photos of ossicles and phosphatic bodies from specimens of *Molpadia magdae* O'Loughlin (in O'Loughlin *et al.* 2013) and *Molpadia violacea* Studer, 1876. a–d, *Molpadia magdae*. a, mid-body irregular table discs, ossicles beginning to phosphatize with small phosphatic bodies present (from NMV F197215); b, caudal fusiform rods, some only with spires (from NMV F197215); c, mid-body irregular table discs and fusiform rod, ossicles beginning to phosphatize (from NMV F68677); d, caudal fusiform rods, one with and one lacking spire (from NMV F68677); e–f, *Molpadia violacea*. e, mid-body phosphatizing table disc (disc 64 μm across; from NMV F165737); f, mid-body phosphatic bodies (from NMV F169293).



Figure 16. Photos of preserved Studer (1876) type specimens from the Kerguelen Islands. a, right lateral view of holotype of *Trachythione muricata* Studer, 1876 (ZMB 2252); b–d, photos of holotype of *Psolidium poriferum* (Studer, 1876) (ZMB 2259, as *Cuvieria porifera*); b, lateral view with oral end left; c, dorsal view with oral end right; d, ventral view with oral end right.

Colour of preserved body variable: oral end and discrete tail frequently off-white; body off-white to blue-grey to grey with fine black to red phosphatic spots or flecks; varying to coalescing spots creating a dark red to black colour with a red-brown hue. Live holotype violet (Studer, 1876).

Distribution. Southern Ocean, Kerguelen Plateau, Kerguelen Islands, *Aurora*, *Pike*, *Shell Banks*, Heard I., 112–628 m. Antarctica, Prydz Bay, Ross Sea and vicinity of the South Orkney and South Shetland Islands.

Remarks. Clark (1908) and Deichmann (1940) were of the opinion that *Molpadia violacea* Studer, 1876 is a junior synonym of *Molpadia musculus* Risso, 1826. This opinion was discussed and upheld emphatically by Pawson (1977). After examining many specimens of *Molpadia* of different sizes, Pawson (1977) had observed the great variability of ossicle form within the same species. Pawson (1977) finally judged that *M. musculus* was cosmopolitan in distribution with a wide bathymetric range of

35–5205 m. O'Loughlin *et al.* (2010) list *Molpadia musculus* Risso, 1826 from Antarctica.

O'Loughlin *et al.* (2010) also showed that recent molecular phylogenetic data are revealing many cryptic species and they provided a phylogenetic tree for CO1 sequence data from 19 specimens judged to be *Molpadia musculus*. The specimens were collected from the Amundsen Sea, Ross Sea and South Shetland Islands in Antarctica, from Heard Island, and from Western Australia. The tree indicates the probability of five cryptic species. One of the species is Antarctic, with specimens from the Ross Sea and the South Shetland Islands, and this clade includes the specimen from Heard Island. None of the five cryptic species includes a specimen from the Mediterranean Sea, the type locality for *Molpadia musculus*. We judge from these data, and the geographical separation, that none of these specimens represents *Molpadia musculus*. We thus raise *Molpadia violacea* Studer, 1876 out of synonymy with *Molpadia musculus* Risso, 1826, and note that Antarctic *Molpadia*

specimens previously referred to *M. musculus* should in some cases now be referred to *Molpadia violacea*.

We have examined specimens of *Molpadia* from Western Antarctica that were previously thought to be *Molpadia musculus* and based on colour, ossicle form and occurrence, the phosphatising and disappearance of calcareous ossicles, the absence of spires on caudal fusiform rods, and in two cases with the support of the genetic data in O'Loughlin *et al.* (2010), we refer them to *Molpadia violacea*. These are listed above. We found only one specimen (NMV F71992) that was collected from Prydz Bay that appears to be *Molpadia violacea*. It exhibits appropriate colouration, no spires on caudal fusiform rods, and abundant phosphatic bodies in the body wall.

We have identified a number of specimens that were previously thought to be *Molpadia musculus*, from Prydz Bay in Eastern Antarctica and the Amundsen Sea in Western Antarctica, as *Molpadia magdae* O'Loughlin (in O'Loughlin *et al.* 2013): from Prydz Bay lots NMV F68058 (1), NMV F197215 (2), NMV F68677 (1), NMV F71993; and from the Amundsen Sea lot NMV F168645 (1). These specimens are characterized by: lack of colour and minimal phosphatising; a body cover of table spires; irregular triradiate table discs that frequently have long rod-like marginal elongations; and asymmetrical fusiform rods caudally, some of which have spires and inter-grade with tables (see Figure 15 a–d). *Molpadia magdae* was described from the South Shetland Islands and this work extends its distribution to Prydz Bay in Eastern Antarctica. We have never detected spires on caudal fusiform rods in specimens of *Molpadia violacea*.

Some distributions of HIMI and Kerguelen Islands holothuroid species beyond the Kerguelen Plateau.

In addition to the holothuroid species reported here for HIMI we add two more to complete a list for the Kerguelen Plateau. *Clarkiella deichmannae* O'Loughlin, 2009 was described for BANZARE specimens taken in the Kerguelen Islands. *Pseudopsolus macquariensis* forma *gruai* Cherbonnier & Guille, 1975 was described for littoral specimens from the Kerguelen Islands. A thorough description was provided and this variety was distinguished from the Macquarie Island species *Pseudopsolus macquariensis* (Dendy, 1897) by the presence of ossicles in body parts where they were consistently reported to be absent by numbers of workers. We raise this "forma" to species status as *Pseudopsolus gruai* Cherbonnier & Guille, 1975.

O'Loughlin *et al.* (2010) provide a comprehensive list of Antarctic holothuroids. O'Hara (1998) reported on nine holothuroid species from Macquarie Island. Subsequently Davey & Whitfield (2013) reported *Psolidium marriotti* Davey & Whitfield, 2013, *Psolus antarcticus* (Philippi, 1857), *Psolus macquariensis* Davey & Whitfield, 2013, *Psolus parantarcticus* Mackenzie & Whitfield, 2011 and *Psolus salottii* Mackenzie & Whitfield, 2011 from the Macquarie Ridge.

Pawson (1969) reported *Heterocucumis godeffroyi* (Semper, 1868) from southern Chile.

The type localities for *Psolus antarcticus* (Philippi, 1857) and *Trachythone lechleri* (Lampert, 1885) are the Straits of Magellan. O'Loughlin & VandenSpiegel (2010) reported a widespread distribution of *Sigmodota contorta* (Ludwig, 1875) in

Antarctica and the southern region of South America (type locality unknown).

Fifteen holothuroid species are reported here for Bouvetoya Island (list compiled from Ludwig & Heding 1935 (*Valdivia* voyage in 1898), Théel 1886 (*Challenger* voyage in 1876), and NMV specimens): *Bathyplores bongraini* Vaney, 1914; *Bathyplores moseleyi* (Théel 1886); *Protelpidia murrayi* (Théel 1879); *Cucamba psolidiformis* (Vaney, 1908); *Heterocucumis steineri* (Ludwig, 1898); *Psolidiella mollis* (Ludwig & Heding, 1935); *Psolocrux coatsi* (Vaney, 1908); *Psolidium whittakeri* O'Loughlin & Ahearn, 2008; *Psolus antarcticus* (Philippi, 1857); *Psolus charcoti* Vaney, 1906; *Psolus dubiosus* Ludwig & Heding, 1935; *Psolus murrayi* Théel, 1886; *Staurocucumis liouvillei* (Vaney, 1914); *Trachythone bouvetensis* (Ludwig & Heding, 1935); *Sigmodota contorta* (Ludwig, 1875). We note that Carriol & Féral (1985) considered a paratype of *Psolus dubiosus* Ludwig & Heding, 1935 to be their *Psolus paradubiosus*. In the absence of supportive material we distrust this judgment, and think that the specimen may be the similar *Psolus antarcticus* that we have found in Bouvetoya waters.

The above reports indicate that the holothuroid fauna of the Kerguelen Plateau has eight species with distributions that are continuous with the relatively shallow fauna of the Antarctic coast, and five species that occur in the Magellanic region of South America. Two of these latter five species have not been found on the coast of Antarctica (*Heterocucumis godeffroyi* and *Trachythone lechleri*).

Of the 15 species reported for Bouvetoya Island, 13 occur on the coast of Antarctica (no reports of *Psolus paradubiosus* or *Psolus murrayi* on the Antarctic coast). Only three are reported for the Kerguelen Plateau (*Psolus antarcticus*, *Staurocucumis liouvillei*, *Sigmodota contorta*).

Two species (*Pentactella laevigata* and *Psolus antarcticus*) reported for Macquarie Island (north of the Antarctic Convergence) occur on the Kerguelen Plateau, the northern part of which has proximity with the Antarctic Convergence. A COI sequence from an HIMI specimen of *Pentactella laevigata* clades with one from the Macquarie Ridge (Gustav Paulay *pers. comm.*).

Acknowledgements

We are grateful to the following persons for their contributions to this paper: Ben Boonen (format of figures); Mark Darragh (formerly at NMV; photographs of ZMB type specimens); Ty Hibberd and Kirrily Moore (formerly of the AAD; identification and curation of HIMI specimens); Carsten Lüter (facilitation of loan of ZMB *Gazelle* specimens in 2001); Kirrily Moore (currently TMAG; for facilitating the loan of specimens and provision of data); David Smith (Australian Antarctic Data Centre; provision of the map in Figure 1, courtesy of the Australian Antarctic Division © Commonwealth of Australia 2015); Dirk Welsford (AAD; assistance with the provision of the Figure 1 map). We are grateful to the AAD for the donation of some HIMI specimens to NMV, and to NMV for the use of facilities. We are most grateful to Frank Rowe (Research Associate of the Australian Museum) for reviewing our manuscript.

References

- Ayres, W. O. 1851. Descriptions of Holothuria. *Proceedings of the Boston Society of Natural History* 4: 11–70.
- Barrett, F. G. S. 1857. Descriptions of four new species of Echinodermata. *Annals and Magazine of Natural History* 22(2)115(7): 46–48, pl. 4.
- Burmeister, H. 1837. Handbuch der Naturgeschichte. *Zweite Abteilung. Zoologie*. Pp. 369–858. Verlag von Theod. Chr. Friedr. Gnelin: Berlin.
- Carriol, R-P. & Féral, J-P. 1985. Réexamen de quelques Psolidae (Holothurioidea, Echinodermata) antarctiques et subantarctiques. Description de deux nouvelles espèces du genre *Psolus*. *Bulletin du Muséum D'Histoire naturelle de Paris* 4(7) A(1): 49–60.
- Cherbonnier, G. 1941. Note sur une nouvelle Holothurie antarctique: *Cucumaria cornuta* nov. sp. *Bulletin Société Zoologique France* 66: 271–270.
- Cherbonnier, G. 1958. Holothuries des côtes de Sierra-Leone (2e note). *Bulletin Muséum National Histoire Naturelle Paris. 2 série* 30: 101–108.
- Cherbonnier, G. 1965 (1964). Holothuries récoltées par A. Crosnier dans le Golfe de Guinée. *Bulletin Muséum National Histoire Naturelle Paris. 2 série* 36(5): 647–676.
- Cherbonnier, G. & Guille, A. 1975. Échinodermes récoltés aux îles Kerguelen. *Bulletin Muséum National Histoire Naturelle Paris. 3 série, no. 300, Zoologie* 210: 603–630.
- Clark, H. L. 1908. The apodous holothurians. *Smithsonian Contributions to Knowledge* 35: 1–231, pls 1–13.
- Cuvier, G. 1817. *Le Règne animal distribué d'après son organisation, pour servir de base à l'Histoire naturelle des animaux et d'introduction à l'anatomie comparée. Volume 4*: 255 pp, 15 pls. Paris.
- Davey, N. & O'Loughlin, M. 2013. The caudinid sea cucumbers of New Zealand (Echinodermata: Holothuroidea: Molpadiidae: Caudinidae). *Zootaxa* 3613 (4): 357–368.
- Davey, N. & Whitfield, E. 2013. The Psolidae of New Zealand and some additions to the Macquarie Ridge fauna (Echinodermata: Holothuroidea: Psolidae). *Memoirs of Museum Victoria* 70: 51–67.
- Deichmann, E. 1930. The holothurians of the western part of the Atlantic Ocean. *Bulletin of the Museum of Comparative Zoology, Harvard* 71(3): 43–236 pls 1–24.
- Deichmann, E. 1938. New holothurians from the western coast of North America and some remarks on the genus *Caudina*. *Proceedings of the New England Zoological Club*, 16, 103–115.
- Deichmann, E., 1940. Report on the Holothurians, collected by the Harvard-Havana expeditions 1938 and 1939, with a revision of the Molpadioidae of the Atlantic Ocean. *Memorias de la Sociedad Cubana de Historia Natural Felipe Poey* 14(3): 183–240, 10 pls.
- Dendy, A. 1897. Observations on the holothurians of New Zealand; with descriptions of four new species, and an appendix on the development of the wheels in *Chiridota*. *Journal of the Linnean Society (Zoology)* 26: 22–52, pls 3–7.
- Ekman, S. 1927. Holothurien der deutschen Südpolar-Expedition 1901–1903 aus der Ostantarktis und von den Kerguelen. *Deutsche Südpolar-Expedition, 19 (Zoology 11)*: 359–419.
- Gebbruk, A. V., Solis-Marin, F. A., Billett, D. S. M., Rogacheva, A. V. & Tyler, P. A. 2012. Review of the genus *Zygothuria* Perrier, 1898 and the Atlantic group of species of the genus *Mesothuria* Ludwig, 1894 (Synallactidae: Holothuroidea) with description of the new species *Mesothuria milleri* sp. nov. *Journal of Natural History*, 46: 5–6, 265–348.
- Grube, A. E. 1840. *Aktinien, Echinodermen und Würmer des Adriatischen und Mittelmeeres*. pp. 33–43, 1 pl. Königsberg.
- Gutt, J. 1990. New Antarctic holothurians (Echinodermata) —I. Five new species with four new genera of the order Dendrochirotda. *Zoologica Scripta*, 19(1): 119–127.
- Haeckel, E. H. 1896. *Systematische Phylogenie der Wirbellosen Thiere (Invertebrata). Zweiter Theil des Entwurfs einer systematischen Stammesgeschichte*. Berlin. 720 pp.
- Hansen, B. 1988. The genus *Staurocucumis* Ekman and its possible affinity with *Echinocucumis* Sars (Holothuroidea, Dendrochirota). In: Burke et al. (Eds.), *Echinoderm Biology*. Balkema, Rotterdam, pp. 301–308, figs 1–5.
- Heding, S. G. 1931. On the Classification of the Molpadiids. Preliminary notice. *Videnskabelige Meddelelser fra Dansk naturhistorisk Forening i København* 92: 275–284.
- Heding, S. G. 1932. *Paracaudina* nom. nov. a correction, together with some remarks concerning the supposed fossil Holothurian *Pseudocaudina brachyura* Broili. *Videnskabelige Meddelelser fra Dansk naturhistorisk Forening i København* 92: 455–456.
- Heding, S. G. 1934. On a new Dendrochirote Holothurian from off Timor. *Annals and Magazine of Natural History* 10(13): 456–464.
- Heding, S. G., 1935. Holothurioidea. I. Apoda, Molpadioidae, Gephyrothurioidea. *The Danish Ingolf Expedition 1895–1896* 4(9): 5–84, pls 1–8. Copenhagen.
- Heding, S. G. 1942. Holothurioidea. II. Asidochirota, Elaspoda, Dendrochirota. *The Danish Ingolf-Expedition* 4(13): 1–39. Hagerup, Copenhagen.
- Hibberd, T. & Moore, K. 2009. *Field identification guide to Heard Island and McDonald Islands benthic invertebrates : a guide for scientific observers aboard fishing vessels*. Australian Antarctic Division.
- Lampert, K. 1885/1886. Die Seewalzen. Holothurioidea. Eine Systematische Monographie. In: Semper, C. (Ed.), *Reisen im Archipel der Philippinen*, 4(3), 1–310, 1 pl.
- Lampert, K. 1889. Die während der Expedition S.M.S. *Gazelle* 1874–1876 von Prof. Dr. Th. Studer gesammelten Holothurien. *Zoologische Jahrbücher. Abtheilung für Systematik, Geographie und Biologie der Thiere* 4: 806–858, pl. 24.
- Lesson, R. P. 1830. *Centurie Zoologique ou Choix D'animaux Rares, Nouveaux ou Imparfaitement Connus*. Levrault, Paris. 244 pp., 80 pls.
- Ludwig, H. 1874/1875. Beiträge zur Kenntnis der Holothurien. *Arbeiten aus dem Zoologisch–Zootomischen Institut in Würzburg* 2: 77–118, pls 6, 7.
- Ludwig, H. 1887. Die von G. Chierchia auf der Fahrt der Kgl. Italienische Corvette *Vettor Pisani* gesammelten Holothurien. *Zoologische Jahrbücher* 2: 1–36, 2 pls.
- Ludwig, H. 1894. The Holothurioidea. XII. Report on an Exploration off the west coasts of Mexico, Central and South America, and off the Galapagos Islands, in charge of Alexander Agassiz, by the US Fish Commission Steamer Albatross during 1891, Lt. Z. L. Tanner USN Commanding. *Memoirs of the Museum of Comparative Zoology at Harvard College* 17(3): 183 pp., 19 pls.
- Ludwig, H. 1898. Holothurien. *Ergebnisse der Hamburger Magalhaensischen Sammelreise 1892/93*, 1: 1–98, 3 pls.
- Ludwig, H. & Heding, S. 1935. Die Holothurien der Deutschen Tiefsee-Expedition. I. Fublose und dendrochirote Formen. *Deutsche Tiefsee-Expedition 1898–1899* 24(2)3–93, 2 pl.
- Mackenzie, M. & Whitfield, E. 2011. An overview of the Australian psolid sea cucumbers (Echinodermata: Holothuroidea: Psolidae) with the description of 5 new species. *Zootaxa* 3037: 21–36.
- Massin, C. 1992. Holothurians (Echinodermata) from Marion and Prince Edward Islands: new and little-known species. *Zoologica Scripta* 21(3), 311–324.

- Mortensen, T. 1925. Echinoderms of New Zealand and the Auckland-Campbell Islands. III–V. Asteroidea, Holothuroidea, Crinoidea. *Videnskabelige Meddelelser fra Dansk naturhistorisk Forening I København* 79: 261–420, text figs 1–70, pls 12–14.
- Müller, J. 1850. Anatomische Studien über die Echinodermen. *Archiv für Anatomie, Physiologie und wissenschaftliche Medizin* 1850: 117–155.
- O'Hara, T. M. 1998. Systematics and biology of Macquarie Island echinoderms. *Memoirs of Museum Victoria* 57(2): 167–223.
- Ohshima, H. 1915. Report on the holothurians collected by the United States Fisheries steamer Albatross in the northwestern Pacific during the summer of 1906. *Proceedings of the United States National Museum* 48(2073): 213–291 pls 8–11.
- Oken, L. 1815. *Oken's Lehrbuch der Naturgeschichte. Teil 3. Zoologie*. 850 pp. C.H. Reclam, Jena.
- O'Loughlin, P. M. 2002. Report on selected species of BAZARE and ANARE Holothuroidea, with reviews of *Meseres* Ludwig and *Heterocucumis* Panning (Echinodermata). *Memoirs of Museum Victoria*, 59(2): 297–325.
- O'Loughlin, P. M. 2009. BAZARE holothuroids (Echinodermata: Holothuroidea). *Zootaxa* 2196: 1–18.
- O'Loughlin, P. M. & Ahearn, C. 2008. Antarctic and Sub-Antarctic species of *Psolidium* Ludwig (Echinodermata: Holothuroidea: Psolidae). *Memoirs of Museum Victoria* 65: 23–42.
- O'Loughlin, P. M., Barmos, S. & VandenSpiegel, D. 2011. The paracaudinid sea cucumbers of Australia and New Zealand (Echinodermata: Holothuroidea: Molpadida: Caudinidae). *Memoirs of Museum Victoria* 68: 37–65.
- O'Loughlin, P. M., Mackenzie, M., Paulay, G. & VandenSpiegel, D. 2014. Four new species and a new genus of Antarctic sea cucumbers with taxonomic reviews of *Cladodactyla*, *Pseudocnus*, *Paracucumidae* and *Parathyronidium* (Echinodermata: Holothuroidea: Dendrochirotida). *Memoirs of Museum Victoria* 72: 31–61.
- O'Loughlin, P. M., Manjón-Cabeza, M.E. & Ruiz, F. M. 2009. Antarctic holothuroids from the Bellingshausen Sea, with descriptions of new species (Echinodermata: Holothuroidea). *Zootaxa* 2016: 1–16.
- O'Loughlin, P. M., Paulay, G., Davey, N. & Michonneau, F. 2010. The Antarctic region as a marine biodiversity hotspot for echinoderms: Diversity and diversification of sea cucumbers. *Deep-Sea Research II* 58: 264–275.
- O'Loughlin P.M., Stępień, A., Kuźniak, M. and VandenSpiegel, D. 2013. A new genus and four new species of sea cucumbers (Echinodermata) from Admiralty Bay, King George Island. *Polish Polar Research* 34(1): pp. 67–86.
- O'Loughlin, P. M. & VandenSpiegel, D. 2010. A revision of Antarctic and some Indo-Pacific apodid sea cucumbers (Echinodermata: Holothuroidea: Apodida). *Memoirs of Museum Victoria* 67: 61–95.
- Panning, A. 1949. Versuch einer Neuordnung der Familie Cucumariidae (Holothuroidea, Dendrochirota). *Zoologische Jahrbücher Abteilung für Systematik, Ökologie Geographie Tiere* 78: 404–470.
- Panning, A. 1962. Bemerkungen über die holothurian familie Cucumariidae (Ordnung Dendrochirota). 3. Die gattung *Pseudocnus* Panning 1949. *Mitteilungen aus dem Hamburgischen Zoologischen Museum und Institut* 60: 57–80.
- Pawson, D. L. 1963. The holothurian fauna of Cook Strait, New Zealand. *Zoology Publications from Victoria University of Wellington* 36: 1–38, 7 figs.
- Pawson, D. L. 1964. The Holothuroidea collected by the Royal Society Expedition to Southern Chile, 1958–1959. *Pacific Science*, 18(4): 453–470.
- Pawson, D. L. 1965. The bathyal holothurians of the New Zealand region. *Zoology Publications from Victoria University of Wellington* 39: 1–33, 7 figs.
- Pawson, D. L., 1968. Some holothurians from Macquarie Island. *Transactions of the Royal Society of New Zealand, Zoology*, 10(15): 141–150.
- Pawson, D. L. 1969. Holothuroidea from Chile. Report No. 46 of the Lund University Chile Expedition 1948–1949. *Sarsia* 38: 121–145.
- Pawson, D. L. 1977. Molpadid sea cucumbers (Echinodermata: Holothuroidea) of the southern Atlantic, Pacific and Indian Oceans. *Biology of the Antarctic Seas VI. Antarctic Research Series* 3(26): 97–123, figs 1–8.
- Pawson, D. L. & Fell, H. B. 1965. A revised classification of the dendrochirote holothurians. *Breviora* 214: 1–7. Museum Comparative Zoology: Harvard.
- Perrier, R. 1905. Holothuriers antarctiques du Muséum d'Histoire naturelle de Paris. *Annales des Sciences Naturelles. Zoologie. Series 8e(1)*: 1–143, 5 pls.
- Philippi, A. 1857. Vier neue Echinodermen des Chilenschen Meeres. *Archiv Naturgeschichte*, 23: 130–134.
- Risso, A. 1826. *Histoire naturelle des principales productions de l'Europe Méridionale et particulièrement de celles des environs de Nice et des Alpes Maritimes*. Paris: F.G. Levrault. Vol. 5: VIII, 1–403, 10 pls.
- Sars, M. 1859. Om tre nye Holothurider af hvilke den ena danner Typus for en nys Slægt. *Videnskabs Selskabet Forhandlingar, Christiania* 1859: 170–179.
- Semper, C. 1867 (1868). Holothurien. *Reisen im Archipel der Philippinen* 1: 1–288, pls 1–40.
- Sluiter, C. P. 1901. Die Holothurien der Siboga Expedition. *Siboga-Expédition* 44: 1–142, pls 1–10.
- Smirnov, A. V. 2012. System of the class Holothuroidea. *Paleontological Journal* 46 (8): 793–832.
- Studer T. 1876. Über Echinodermen aus dem antarktischen Meere und zwei neue Seeigel von den Papua-Inseln gesammelt auf der Reise S.M.S. Corvette *Gazelle* um die Erde. *Monatsbericht der Königlich-Preussischen Akademie der Wissenschaften zu Berlin* 1876: 425–465.
- Théel, H. 1879. Preliminary report on the Holothuridae of the exploring voyage of H.M.S. *Challenger*. 1. Bihang till Kongl. Svenska Vetenskaps-Akademiens Handlingar, 5(19): 1–20, pls 1–2.
- Théel, H. 1886. Report on the Holothuroidea dredged by H.M.S. *Challenger* during the years 1873–1876. *Report on the scientific results of the voyage of H.M.S. Challenger, Zoology* 14 (39): 1–290, 16 pls.
- Thomson (Wyville-), C. 1877. Notice of some peculiarities in the mode of propagation of certain echinoderms of the Southern Sea. *Journal of the Linnean Society of London (Zoology)* 13: 55–79.
- Vaney, C. 1906. Deux nouvelles holothuries du genre *Thyone* provenant des Orcades du Sud. *Bulletin du Muséum d'Histoire naturelle, Paris* 12: 400–402.
- Vaney, C. 1908. Les Holothuries de l'Expédition Antarctique Nationale Écossaise. *Transactions of the Royal Society of Edinburgh* 46: 405–441, 5 pls.
- Vaney, C. 1914. Holothuries. Deuxième Expédition Antarctique Française (1908–10). *Sciences Naturelles: Documents Scientifiques*, 54 pp., 5 pls.
- Verrill, A. E. 1876a. Echinodermata. Holothuroidea. *Pentactella* g. n. Pp. 68–69 in Kidder, J. H. (ed.). *Contributions to the Natural History of Kerguelen Island*. Harvard University Herbarium.
- Verrill, A. E. 1876b. Annelids and Echinoderms, and Anthozoa in *Contributions to the Natural History of Kerguelen Island. Bulletin of the United States National Museum* 3: 64–77.

Micheleidae (Crustacea: Decapoda: Axiidea): new family, generic and species synonymies, three new Australian species, and new records

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Abstract

Poore, G.C.B. and Collins, D.J. 2015. Micheleidae (Crustacea: Decapoda: Axiidea): new family, generic and species synonymies, three new Australian species, and new records. *Memoirs of Museum Victoria* 73: 95–105.

The Micheleidae are shown to include all taxa previously separated as Meticonaxiidae. A revised key to genera, *Marcusiaxius*, *Meticonaxius*, *Tethisea* and *Michelea* is presented. *Meteoraxius* Sakai and Türkay, 2012 is synonymised with *Meticonaxius* de Man, 1905. *Micheleopsis* Sakai, 2010 is synonymised with *Michelea* Kensley and Heard, 1991; among other quite trivial differences, the genus had been differentiated on a simple form of the male pleopod 1, suspected to be a juvenile feature and/or lacking merit as a generic character. Three new species, *Michelea kalbarri*, *M. imperieusae* and *Tethisea alanwilliamsi* are described. *Michelea kalbarri* is unique in its genus in lacking pleopodal lamellae. *Michelea novaecaledoniae* Poore, 1997 is added to the Australian fauna. *Michelea paleura* is synonymised with *M. leura*.

Keywords

Crustacea, Decapoda, Axiidea, Meticonaxiidae, Micheleidae, *Meticonaxius*, *Tethisea*, *Michelea*, new species

Introduction

The family Micheleidae Sakai, 1992 sensu lato was reviewed globally by Poore (1997) who recognised 26 species in four genera. Two genera and five species have been added since (Lin, 2006; Liu and Liu, 2012; Poore, 2008; Sakai, 2010). Poore (1994, 1997) treated two subfamilies, Meticonaxiinae Sakai, 1992 and Micheleinae Sakai, 1992, as synonymous but they were revived at the family level by Sakai (2011). Here, this disagreement is reviewed in the light of a reappraisal of morphological characters with support from molecular analyses. The two recent genera are assessed and found to be synonymous with others of long standing. Finally, three new Australian species are described while making their generic diagnoses more flexible.

With most species represented by few specimens growth changes are poorly understood. Here, we present evidence that the fully-formed male pleopod 1, a stalked triangular blade, may not be present in juvenile males, and then develops through bud-like forms over more than one instar. This variability needs to be taken into taxonomic account at the species and genus level.

This is the second of two papers dealing in part with collections of Axiidea made as part of a project mounted by CSIRO Marine and Atmospheric Research (CMAR) and Museum Victoria entitled “Mapping benthic ecosystems on the deep continental shelf and slope in Australia’s South West Region” (Poore and Collins, 2009). The project has shown the

decapod crustacean fauna to be rich and diverse (Poore et al., 2008). The material collected in the south-west is supplemented by more taken along the north-western Australian slope and by collections from the Northern Territory.

Material is deposited in Museum Victoria, Melbourne (NMV), the Northern Territory Museum and Art Gallery, Darwin (NTMAG) and the US National Museum of Natural History, Washington (USNM). Measurements are of carapace length (cl.) including rostrum.

One family or two?

Kensley and Heard (1991) reviewed the Callianideidae Kossmann, 1880, including seven genera. Their PAUP analysis of morphological characters resulted in three clades comprising: (1) *Callianidea* H. Milne Edwards, 1837; (2) *Mictaxius* Kensley and Heard, 1991, *Crosniera* Kensley and Heard, 1991 and *Thomassinia* de Saint Laurent, 1973; and (3) *Marcusiaxius* Rodrigues and de Carvalho, 1972, *Meticonaxius* de Man, 1905 and *Michelea* Kensley and Heard, 1991. The three clades were united by absence of a suture on the uropodal endopod, flattened pereopods 3 and 4, setal rows on pleomeres and pereopods 2–4. The first two of these clade are now treated as Callianideidae s.s., with Thomassinidae treated as a junior synonym (Dworschak et al., 2012; Poore, 2015).

It is a moot point whether one or two families should be recognised for the genera of Kensley and Heard’s (1991) third clade. Sakai (1992) introduced two subfamilies of

Callianideidae, Micheleinae for *Michelea* and Meticonaxiinae for the others. Poore (1994) synonymised the two subfamilies relying on the paraphyly of three meticonaxiine genera, *Marcusiarius*, *Meticonaxius* and *Tethisea* Poore, 1994. While he found numerous synapomorphies for *Michelea*, none supported grouping of the others. This argument was followed by Poore (1997) who stated that numerous synapomorphies united all taxa. This analysis was criticised by Sakai (2011) in support of retention of his original taxa at family level. He believed the characters used were of “no significance” compared to others relying instead on the rostrum being obsolete in *Michelea* and produced in the other genera and differences in pleopods, propodi of pereopods 3 and 4, pleurobranchs, the telson and uropodal endopod. Of these characters only the rostrum, pleopods and pereopodal propodi were listed in his family diagnoses; other characters in his diagnoses are essentially identical in the two families. He erroneously contrasted pereopod 5 in the two families – it is subchelate in both. Sakai’s (2014) amended key to axiidean families separated the two families Micheleidae and Meticonaxiidae on the size of the rostrum, ‘small’ in the former and ‘distinct’ in the latter. The two lines of his couplet 6 are virtually identical and would not separate Micheleidae (*Michelea*) from Callianideidae as they are intended to do.

The difference of opinion is not so much about whether *Michelea* differs from the others or not but on whether ‘Meticonaxiidae’ can be defined as a monophyletic taxon. No morphological evidence supports their monophyly. Robles et al.’s (2009: fig. 1) Bayesian analysis of 16S and 18S data contained just two sister species, *Michelea* sp. and *Tethisea mindoro* Poore, 1994, so contributed nothing to the Meticonaxiidae/Micheleidae question. A more complete analysis of basal axiidean taxa by the same authors is available as part of an ongoing analysis aimed principally at elaborating the relationships of Callianassoidea first explored by Felder and Robles (2009). This as yet unpublished cladogram shows *T. mindoro* to be sister taxon to a clade containing three species of *Meticonaxius* on one branch and two species of *Michelea* on another (R. Robles, pers. comm., Jan 2014). This result accords with the conclusion of Poore (1994, 1997).

Micheleidae Sakai, 1992

Micheleinae Sakai, 1992: 18.

Meticonaxiinae Sakai, 1992: 19.

Micheleidae.—Poore, 1994: 99.—Poore, 1997: 354–357.—Poore, 2004: 176.—Poore, 2008: 174.—Sakai, 2011: 311.—Dworschak et al., 2012: 190.—Sakai, 2014: 611 (key).

Meticonaxiidae.—Sakai, 2011: 297–301.—Sakai and Türkay, 2014: 161.—Sakai, 2014: 611 (key) **Syn. nov.**

Diagnosis. Cephalothorax, rostrum, pleon, telson and uropod unarmed. Rostrum obsolete or a flat triangular plate with sublateral carinae extending almost to cervical groove. Linea thalassinica absent. Posterior margin of carapace curved medially, with lateral lobes interacting with pleomere 1. Thoracic sternite 7 broad, flattened posteriorly, narrow anteriorly. Setal-rows present usually on anterolateral carapace,

on lateral face of propodi of pereopods 2–4, and on pleomeres 1 and 6 and sometimes others. Eyestalks cylindrical, tapering; sometimes without pigmented eyes. Antenna with articulating scaphocerite. Maxilla scaphognathite with 1 or 2 long setae on posterior lobe extending into branchial chamber. Maxilliped 3 pediform. Pereopod 1 (cheliped) merus lower margin straight, sometimes with spine. Pereopod 2 chelate. Pereopod 3 propodus ovate or subrectangular; pereopods 3 and 4 propodi with or without distal spiniform seta on lower margin (facial spiniform setae in *Michelea*). Male pleopod 1 with triangular second article, appendix interna represented by hooks. Pleopods 2–5 similar, with elongate rami, each with elongate appendix interna, with or without marginal plates. Uropod endopod ovate; exopod without dorsal plate.

Remarks. The family contains four genera of which *Marcusiarius* Rodrigues and de Carvalho, 1972 has not been reported from Australia. The genus and its type species *M. lemoscastroi* were validly published by Rodrigues and Carvalho (1972) and redescribed by Carvalho and Rodrigues (1973) both in another journal later. Sakai (2011) erroneously maintained without explanation that the latter were first authors. The other genera are discussed below.

Key to genera of Micheleidae

Remarks. Poore’s (1997) review included four genera. Two have been added since, *Micheleopsis* Sakai, 2010 which can not be clearly distinguished from *Michelea*, and *Meteoraxius* Sakai and Türkay, 2012 which can not be distinguished from *Meticonaxius* de Man, 1905 (see discussions below). These and the discovery of species that are atypical of their genera necessitates redrafting and correcting Poore’s (1997) key to genera. Sakai’s (2011: 298–300) key to ‘Meticonaxiidae’ is simpler but less reliable.

1. Rostrum minute, triangular; usually without pleurobranchs above pereopod 2–4; usually with pleopodal lamellae; pereopods 3 and 4 with lateral spiniform setae. *Michelea*
- Rostrum prominent, flat; usually with pleurobranchs above pereopod 2–4; without pleopodal lamellae; pereopods 3 and 4 without lateral spiniform setae 2
2. Uropodal endopod with anterior margin convex, ending by curving to rounded posterior margin; maxilliped 1 exopod with second linear article; pleomeres 3–5 without setal-rows *Tethisea*
- Uropodal endopod with straight anterior margin ending sharply; maxilliped 1 exopod without second article; pleomeres 3–5 with setal-rows 3
3. Eyes visible in dorsal view, rostrum narrowly rounded or acute; cheliped fixed finger with major tooth two-thirds way along; uropodal endopod at most 1.5 times as long as wide *Meticonaxius*
- Eyes not visible in dorsal view, rostrum broadly rounded, bullet-shaped; cheliped fixed finger with major tooth one-third way along; uropodal endopod about twice as long as wide *Marcusiarius*

***Meticonaxius* de Man, 1905**

Meticonaxius de Man, 1905: 592.—Poore, 1997: 364–365 (for synonymy).—Sakai, 2011: 305–306.

Meteoraxius Sakai and Türkay, 2012: 731–732 (type species *Meteoraxius meteor* Sakai and Türkay, 2012, by original designation). **Syn. nov.**

Remarks. *Meticonaxius* has a long synonymy (see Poore, 1997). Sakai and Türkay (2012) compared their new genus and species, *Meteoraxius meteor*, with *Marcusiarius* from which it differs in several features. Unfortunately, they did not compare it with *Meticonaxius* from which it can not be distinguished. Both genera vary in few characters that might be considered of generic value. The rostrum of species of *Meticonaxius* is narrower than that of species of *Marcusiarius*; in some the apex is rounded and others acute but the eyes are always visible dorsally, unlike in *Marcusiarius* where the broadly rounded rostrum covers the eyes. *Meteoraxius meteor* lacks setal rows on the carapace; the number recorded throughout the 15 species of both genera ranges from one to three so absence could not be considered of generic value. The species has a moderately developed crista dentata on maxilliped 3; it is absent in *Marcusiarius* but variably developed in *Meticonaxius* species. *Meteoraxius meteor* has a long maxilliped 3 exopod; is usually rudimentary in these genera but can be as long as half the ischium. *Meteoraxius meteor* has the same shaped telson, longer than wide, as in all other species of *Meticonaxius*, different from the short telson of *Marcusiarius* species. The uropodal endopod of *M. meteor* has a triangular apex and the exopod rounded. Similar uropods are seen in some species of *Meticonaxius* but in others the exopod ends more squarely. *Meteoraxius* post-dates and was not included in the review of Sakai (2011). The genus is here synonymised with *Meticonaxius*.

Sakai (2011) excluded *Meticonaxius longispina* (Stebbing, 1920) and *M. microps* (Bouvier, 1905) from this genus, placing them in *Marcusiarius* instead. He argued that the rostrum in both species ‘is not so acutely triangular as in *Meticonaxius*, but obtusely triangular as in *Marcusiarius*.’ While the rostrums of these two species are more rounded than in other species of *Meticonaxius* both have dorsally visible eyes, broad uropodal endopod and more distally placed tooth on the fixed finger, all characteristic of this genus. The rostrum of species of *Marcusiarius* can not be referred to as ‘obtusely triangular’.

Poore (1997) provided a key to eight species of *Meticonaxius*. Lin (2006) added another and tabulated characters of nine species. Sakai and Türkay (2014) redescribed and illustrated *M. coeca* (Balss, 1921) from Tanzania and removed it from synonymy of *M. monodon* de Man, 1905 from Indonesia. Species now number ten.

Meticonaxius is represented in Australia only by *M. soela* Sakai, 1992 at 300 m in the Coral Sea.

***Michelea* Kensley and Heard, 1991**

Michelea Kensley and Heard, 1991: 519.—Poore, 1997: 373–375.—Poore, 2008: 175.—Poore, 2004: 176–177.—Sakai, 2011: 311–312.

Micheleopsis Sakai, 2010: 1462 (type species *Micheleopsis orlik* Sakai, 2010, by original designation) **Syn. nov.**

Remarks. Poore (1997) diagnosed the genus and provided a key to the ten species known. *Michelea dampieri* Poore, 2008, *Michelea takeda* Liu and Liu, 2012, *Michelea orlik* (Sakai, 2010) transferred from *Micheleopsis*, and the two new species described below can be added to his list. Members of the genus can usually be recognised by the presence of lamellae on the edges of the pleopodal rami but one of the new species described below lacks these lamellae. Otherwise, the extremely short rostrum, laterally compressed carapace, pereopodal setation, ovate uropodal rami, cylindrical eyestalks and the elongate first article of the antennule characterise the genus.

Sakai (2010) erected the new genus *Micheleopsis* that he said looks superficially similar to *Michelea*. For the important generic characters listed above the two do not differ. He noted that the carapace of the new genus (represented by a single individual of one species, *M. orlik*) bears a dorsolateral carina running from each side of the rostrum to the posterior third of the gastric region – a similar carina has been illustrated for *M. microphylla* Poore, 1997 and is hinted at in other illustrations. The character would seem to rely on authors’ interpretations and illustrations. He noted that the maxilliped 3 exopod is rudimentary – it exceeds the ischium in all other species. This is one of several variable features of the genus, notably the number of gills and pleopodal lamellae, treated as being of specific value. Neither difference warrants separating a new genus from *Michelea* and it is here synonymised.

Sakai (2010) also stated that the specimen of *M. orlik* was a male with uniramous pleopods 1, with distal patches of hooks, and 2-articulate pleopod 2 endopods without an appendix masculina. His illustration seems of a somewhat distorted, damaged or teratological ramus – nothing like it appears elsewhere in axioids. Adult males of seven species of *Michelea* are known: *M. abranchiata* Poore, 1997, *M. dampieri*, *M. devanyi* Poore, 1997, *M. imperieusae* sp. nov., *M. leura* (Poore and Griffin, 1979), *Michelea takeda* and *M. vandoverae* (Gore, 1987) – all have a male pleopod 1 typical of species in all micheleid genera, a stalked triangular blade with mesial hooks, and an appendix masculina on pleopod 2. Other species are known only from females or males in which pleopod 1 is absent or bud-like. The male holotype of *M. lepta* (Sakai, 1987) lacks pleopod 1 and an appendix masculina on pleopod 2; *M. microphylla* Poore, 1997 has an obsolete simple pleopod 1 and lacks an appendix masculina. Representatives of all species being so few, growth-related change in micheleids has not been reported. Seven males of *M. vandoverae* (cl. 4.1–6.2 mm, USNM collections) all possess a typical pleopod 1 (C.C. Tudge, pers. comm. 9 Mar 2013). In this paper we report a male of *M. leura* without a male pleopod 1, of which a male, previously identified as its synonym *M. paraleura* Poore, 1997, possesses a fully-formed pleopod.

The same variation occurs in *Tethisea* (see below). Dworschak (2008) documented similar changes in pleopod 1 in a somewhat related species, *Neocallichirus karumba* (Poore and Griffin, 1979). We conclude that full formation of the male pleopod 1 may occur over more than one instar (absence to bud-like to triangular). Genera based on what could be juvenile features, such as a less than fully formed male pleopod 1, can not be justified while uncertainty remains over allometric changes.

Micheleopsis is treated here as a junior synonym of *Michelea*. Neither the genus nor its only species was mentioned by Sakai (2011) in his otherwise comprehensive summary of *Michelea* and its included taxa.

About half of the 13 species of *Michelea* are Australian: *M. dampieri* Poore, 2008, *M. microphylla* Poore, 1997, *M. hortus* Poore, 1997, *M. leura* (Poore and Griffin, 1979), *M. novaecaledoniae* Poore, 1997 newly recorded, and two newly erected here.

***Michelea imperieusae* sp. nov.**

Figure 1

Michelea sp. MoV5530.—McCallum, 2012: 57.

Material examined. Holotype. Western Australia, *RV Southern Surveyor* Imperieuse L23 transect (18°27.37'S–18°27.43'S, 120°08.41'E–120°08.41'E), 80–81 m, 19 Jun 2007 (stn SS05/2007/082), NMV J55702 (male, cl 3.5 mm, fixed in 96% ethanol).

Diagnosis. Gills fully developed. Pleopods 2–5 with 20/5, 19/10, 20/15 and 20/15 marginal lamellae on endopods/exopods respectively. Telson tapering, length 1.1 width. Maxilliped 3 ischium with obsolete crista dentata, exopod longer than ischium; merus with mesial tooth.

Description. Cephalothorax 0.25 total length, about 1.8 times as long as greatest depth; rostrum acute, sharply narrowing from broad base, slightly depressed distally, about 0.7 as long as eyestalks; cervical groove weakly defined, reaching 0.65 length of cephalothorax; longitudinal setal-row level with lateral margin of eyestalk, of 6 setae; marginal setal-row of 2 setae at base of eyestalk.

Pleomere 1 with dorsolateral longitudinal setal-row of 6 setae. Pleomeres 2–4 with transverse setal-row of about 6 setae near lateral posterior margin; pleomere 5 with transverse setal-row of 8 setae; all somites also with groups of long simple setae, none with marginal setal-rows. Pleomere 6 with 2 transverse setal-rows of 3 setae.

Antennule with elongate waisted article 1, 0.4 times length of cephalothorax; articles 2 and 3 subequal, each about 0.25 length of article 1; flagella each of 10 articles, longer than peduncle. Antenna with distinct articulating scaphocerite, about third length of article 2; article 4 reaching to middle of article 2 of antenna 1; article 5 short; flagellum of 20 articles, more than twice as long as peduncle.

Mandible, maxillules, maxillae, maxillipeds 1 and 2 typical of genus. Maxilliped 3 ischium with obsolete crista dentata; merus with strong mesial tooth; exopod 1.7 times ischium length.

Chelipeds unknown.

Pereopod 2 merus–propodus with lower marginal rows of long setae; carpus 0.55 length of merus; propodus little longer than carpus with setal-row of 7 short setae; fixed finger cutting edge with 4 short spiniform setae; dactylus longer than fixed finger, with 3 short spiniform setae on distal half of cutting edge; each finger with corneous tip. Pereopod 3 propodus twice as long as wide, with 4 spiniform setae on lower margin, plus 2 on distal-lower and 2 on distal-upper mesial face; and 2 transverse setal-rows of 3 and 2 setae; dactylus with 2

spiniform setae on upper-mesial margin. Pereopod 4 propodus 3 times as long as wide, 9 spiniform setae, some in pairs, on lower mesial face, and 6 on upper margin, and transverse setal-row of 4 setae; dactylus with 3 spiniform setae on upper-mesial margin. Pereopod 5 subchelate; propodus with setae on lower margin; fixed finger with 5 spiniform setae.

Pleopods 1 of male curved mesially, expanded distally, with c. 8 minute hooks, setose around midpoint and laterally, and with 1 simple seta at apex. Pleopod 2 with 20/5 marginal lamellae on endopod/exopod respectively; appendix masculina third length of endopod; appendix interna half length of appendix masculina. Pleopod 3 with appendix interna sac-like, 3 times as long as wide; with 19 lamellae on endopod, 10 on exopod; pleopods 4 and 5 each with 20 lamellae on endopod, 15 on exopod.

Uropodal endopod ovate, 1.6 times as long as wide, with a minute distal tooth; exopod ovate, 1.8 times as long as wide, mesiodistal margin oblique, lateral margin with 5 short spiniform setae. Telson tapering to rounded apex from one-quarter length; 1.15 times as long as wide.

Gills fully developed.

Distribution. Western Australia, 18°S, 120°E, 80 m.

Etymology. *Imperieusae*, from Imperieuse Reef, near the type locality, noun in genitive case.

Remarks. Although the chelipeds are missing we are confident that this is a new species closest to *M. hortus*. It differs in having more pleopodal lamellae (*M. hortus* has only four or five marginal lamellae on the pleopodal endopods and none on the exopods), and more elongate uropodal rami (endopod and exopod 1.4 and 1.6 times as long as wide respectively) and telson (as wide as long).

***Michelea kalbarri* sp. nov.**

Figure 2

Michelea sp. MoV4969.—Poore et al., 2008: 95.

Material examined. Holotype. Western Australia, off Kalbarri (27°48.29'S–28°29.22'S, 113°17.49'E–113°25.08'E), 123–112 m, 04 Dec 2005 (stn SS10/2005/096), NMV J53462 (female, cl 3.4 mm).

Diagnosis. Gills fully developed. Pleopods 2–5 without marginal lamellae. Telson tapering to rounded apex, length 1.2 width. Maxilliped 3 ischium with obsolete crista dentata; merus with mesial tooth.

Description. Cephalothorax 0.37 total length, about 1.7 times as long as greatest depth; rostrum acute, sharply narrowing from broad base, slightly depressed distally, about 0.7 as long as eyestalks; cervical groove weakly defined, reaching 0.7 length of cephalothorax; longitudinal setal-row level with lateral margin of eyestalk, of 5 setae; marginal setal-row of 5 setae at base of eyestalk.

Pleomere 1 without dorsolateral longitudinal setal-row. Pleomeres 3–5 with transverse setal-rows of 6–7 setae near midpoint; all somites also with groups of long simple setae, none with marginal setal-rows. Pleomere 6 with transverse setal-row of 4 setae.



Figure 1. *Michelea imperiusae* sp. nov. Holotype, NMV J55702. a, habitus. b, anterior carapace, with antennules, antennae, lateral view. c, telson and uropods. d, maxilliped 3. e–f, pereopods 2–3. g–i, male pleopods 1–3. Scale bar applies to habitus only.



Figure 2. *Michelea kalbarri* sp. nov. Holotype, NMV J53462. a, habitus. b, c, anterior carapace, antennules and antennae, lateral and dorsal views. d, telson and uropods. e, maxilliped 3. f–j, cheliped, pereopods 2–5, with detail of dactyli. k, pleopod 3. Scale bar applies to habitus only.

Antennule with elongate waisted article 1, 0.4 length of cephalothorax; articles 2 and 3 subequal, each about 0.25 length of article 1; flagella each of 14 articles, longer than peduncle. Antenna with distinct articulating scaphocerite, about half length of article 2; article 4 reaching to middle of article 3 of antennule; article 5 short; flagellum of 17 articles, more than twice as long as peduncle.

Mandible, maxillules, maxillae, maxillipeds 1 and 2 typical of genus. Maxilliped 3 ischium with obsolete crista dentata; merus with strong mesial tooth; exopod 1.7 times ischium length.

Chelipeds equal; ischium with weak lower tooth; merus twice as long as deep, upper margin convex, with weak tooth on slightly convex lower margin; carpus unarmed; propodus almost cylindrical, 3.5 times as long as deep; fixed finger 0.37 total length of propodus, its cutting edge with 1 obsolete tooth at midpoint; dactylus cutting edge straight, curved distally, equal to fixed finger.

Pereopod 2 merus-propodus with lower marginal rows of long setae; carpus 0.5 length of merus; propodus 1.3 times as long as carpus, with setal-row of 5 short setae; fixed finger cutting edge with 5 short spiniform setae; dactylus longer than fixed finger, with 4 short spiniform setae on distal half of cutting edge; each finger with corneous tip. Pereopod 3 propodus 2.5 times as long as wide, with 2 spiniform setae on distal-upper mesial face, 7 on distal-lower face; and 2 transverse setal-rows of 3 and 4 setae; dactylus with 3 spiniform setae on upper margin. Pereopod 4 propodus 3.5 times as long as wide, with 3 spiniform setae on lower margin, 3 spiniform setae and numerous pectinate distally; with transverse setal-row of 3 setae; dactylus with 4 spiniform setae on upper-mesial margin. Pereopod 5 semichelate; propodus with setae on lower margin transforming to strongly pectinate distally; fixed finger with 4 distal spiniform setae; dactylus without spiniform setae.

Pleopods 2–5 without marginal lamellae; appendix interna sac-like, 3 times as long as wide.

Uropodal endopod ovate, 1.65 times as long as wide, with a minute distal tooth; exopod ovate, almost twice as long as wide, lateral margin with about 20 short spiniform setae. Telson tapering to rounded apex from one-third length; 1.2 times as long as wide.

Branchial formula (f = filamentous; r = rudimentary):

Thoracomere	1	2	3	4	5	6	7	8
Arthrobranch	–	r	1	2	2	2	2	–
Epipod	1	1	1	1	1	1	1	–
Podobranch	–	–	f	f	f	f	–	–

Distribution. Western Australia, 27°S, 113°E, 112–123 m.

Etymology. The specific name is that of a town near the type locality; noun in apposition.

Remarks. *Michelea kalbarri* is notable for the absence of pleopodal lamellae on both rami, present on at least one ramus in all other species. While this feature has been treated as a key generic character the numbers of lamellae are highly variable, being absent on exopods of three species (Sakai, 2011) while the maximum is almost 100 on both rami in *M. lamellosa* Kensley and Heard, 1991. In all other respects, general habitus and pereopods, the species is a typical member of *Michelea*.

Michelea novaecaledoniae Poore, 1997

Michelea novaecaledoniae Poore, 1997: 388–390, fig. 22.—Sakai, 2011: 316.

Material examined. Coral Sea, Chesterfield Reef (19°06'S, 158°53'E), 32–60 m, R. Hanley, 27 Jul 1988 (NTMAG Cr013049, female; NTMAG Cr013052, ovigerous female with 10 embryos, cl 4.3 mm).

Distribution. New Caledonia, 22°S, 166°E, and Chesterfield Reef, Coral Sea, 19°S, 158°E, 32–60 m.

Remarks. The pleopods and tailfan are consistent with the description of the type specimen from New Caledonia. The endopods of pleopods 3 and 4 have three and four lateral lamellae plus one mesially. This is the first record of an ovigerous female of *Michelea*. It is striking for the paucity of embryos (ten only) and their large oval size, 1.8 x 1.1 mm, 0.4 of the carapace length. This second record extends the species' distribution.

Michelea leura (Poore and Griffin, 1979)

Callinideia leura Poore and Griffin, 1979: 281–284, figs 40, 41.—Sakai, 1984: 104.

Michelea leura.—Kensley and Heard 1991 : 519.—Poore, 1997: 381–386, figs 17–19.—Sakai, 2011: 315.

Michelea paraleura Poore, 1997: 390–393, figs 23, 24.—Sakai, 2011: 316. **Syn. nov.**

Material examined. Australia, NT, Port Essington, Mangrove Point Reef (11°24.0'S, 132°11.0'E), LWS, R. Hanley, 15 Sep 1985 (NTMAG Cr013206, juvenile male, cl 2.5 mm).

Distribution. NT, Qld, 11°–19°S, reef, 1–2 m.

Remarks. Poore's (1997) arguments separating *M. paraleura* from *M. leura* seem now unconvincing. The new juvenile male, three-quarters the size of the figured paratype male from NT, lacks a first pleopod. The appendix masculina carries fewer setae than in the paratype. The numbers of lamellae on the endopod and exopod of pleopod 2 are fewer (17, 13) than those of the larger paratype (26, 15) but more are evident on more posterior pleopods. The species was previously recorded from the Great Barrier Reef, Qld, and Oxley Island, NT. This record takes the species to mainland Australia.

Tethisea Poore, 1994

Tethisea Poore, 1994: 99–100.—Poore, 1997: 393–394.—Sakai, 2011: 309.

Remarks. The rostrum, tapering truncate telson and ovate uropodal endopod of the new species described here are of the same form as those of the two species of *Tethisea* Poore, 1994 (Poore, 1997). The new species differs significantly in the absence of strong spiniform setae in the gape of the cheliped and the blunt, rather than attenuating and acute cheliped fingers. As in *Michelea* discussed above, the male pleopod 1 varies within and possibly between species. The male pleopod 1 of the new species is of the triangular form typical of adult micheleids. Of seven males of *T. mindoro* Poore, 1997 in Museum Victoria the two larger specimens (cl, 5.0, 6.5 mm) possess bud-like pleopods 1 and in five specimens (cl, 2.2–5.0

mm) pleopod 1 is absent. None has a triangular pleopod 1 but might be anticipated in a larger male. The appendix masculina is present on all pleopods 2.

Besides the new species described below, *Tethisea mindoro* occurs in Western Australia, the only Australian state in which the genus occurs.

***Tethisea alanwilliamsi* sp. nov.**

Figures 3, 4

Tethisea sp. MoV5472.—Poore et al., 2008: 95.

Material examined. Holotype. Western Australia, off Pt Hillier (35°22.53'S–35°22.56'S, 117°12.11'E–117°11.31'E), 419–460 m, 22 Nov 2005 (stn SS10/2005/096), NMV J55604 (male, cl 9.7 mm).

Diagnosis. Rostrum with convex lateral margins meeting at subacute tip. Maxilliped 3 without exopod. Cheliped without strong spiniform setae in gape; fingers moderately stout, not finely attenuating. Uropodal exopod 1.3 times as long as wide.

Description. Cephalothorax 0.35 total length, about 1.1 times as deep as wide; rostrum with convex lateral margins, obscuring eyes from dorsal view, meeting at subacute tip, slightly depressed distally, with dorsal setae along lateral carinae, 1.6 times as long as broad at base of eyes, almost 3 times as long as eyestalks; lateral carinae extending on to cephalothorax, without median carina; cervical groove weakly defined; dorsoposterior margin a convex medial lobe, separated from posterolateral margins; without setal-row.

Pleomere 1 narrower than pleomere 2, with anterolateral lobes overlying posterolateral margins of cephalothorax; pleuron without marginal spine; dorsolateral setal-row of 7 setae. Pleomere 2 1.5 times as long as first, pleuron broadly overlapping first somite. Pleomeres 2–5 without setal-rows. Pleomere 6 with longitudinal setal-row of about 10 setae.

Eyestalks acute distally, cornea pale, distal.

Antennule with article 1 shorter than rostrum; articles 2 and 3 subequal, each about 0.4 length of article 1; flagella each of c. 14 articles, longer than peduncle. Antenna with long acute articulating scaphocerite, 0.85 length of article 4; article 4 reaching to near end of article 3 of antenna 1; article 5 short.

Mandible, maxillae, maxillipeds 1 and 2 typical of genus. Maxilliped 3 ischium with crista dentata of 7 blunt teeth; merus without mesial tooth; ischium–merus with dense mesial rows of long setae; carpus–dactylus longer than ischium–merus; exopod almost semicircular, length about half width of ischium.

Chelipeds equal in size but with slight variation in spination; ischium with distal spine on lower margin; merus with 3 (right) and 2 (left) spines on lower margin, upper margin strongly convex; carpus unarmed, carinate on upper margin; propodus 2.8 times as long as deep, deepest at midpoint, with carinate upper and lower margins, almost folded over on upper; fixed finger 0.3 length of propodus, with proximal blunt tooth on cutting edge, more prominent on left; gape slight, without long spiniform setae laterally; dactylus cutting edge concave proximally, blunt. Pereopod 2 merus–propodus with lower marginal rows of long setae; carpus 0.6 length of merus; propodus as long as carpus, without setal-row; fixed finger cutting edge with numerous contiguous spiniform setae;

dactylus longer than fixed finger, straight. Pereopod 3 propodus 1.3 times as long as wide, upper and lower margins convex, posterior face densely setose, the whole forming a shallow oval dish-like surface, without setal-row; dactylus broad. Pereopod 4 propodus 1.8 times as long as wide, without setal-row; dactylus broad. Pereopod 5 propodus with short fixed finger; dactylus curved, about 3 times as long as fixed finger, distally rounded.

Pleopods 1 of male 2-articled, second article 4 times as long as wide, with medial lobe bearing minute hooks. Pleopod 2 missing. Pleopod 3 endopod 3.8 times as long as wide; appendix interna 10 times as long as wide; exopod twice as long as wide, ovate. Pleopods 4 and 5 essentially similar to pleopod 3.

Uropodal endopod with anterior margin weakly convex, ending by curving to rounded posterior margin, 1.3 times as long as wide; exopod with shallow concave anterior margin, apically rounded, posterior margin broadly lobed, 1.3 times as long as wide; with uneven robust setae among many plumose setae. Telson 1.1 times as long as wide, tapering to truncate apex beyond constriction one-third way along.

Distribution. Western Australia, 35°S, 117°E, 419–460 m.

Etymology. For Alan Williams, CSIRO Marine Laboratories, Hobart, promoter and organiser of the much-appreciated Voyages of Discovery research program, especially in Western Australia.

Remarks. *Tethisea alanwilliamsi* differs from *T. indica* Poore, 1994 and *T. mindoro* Poore, 1997 in the absence of strong spiniform setae in the gape of the cheliped. The outline of the rostrum in dorsal view is intermediate between that of the described species; the cheliped is more robust and its fingers not of their attenuating acute form.

Acknowledgements

We are grateful to many colleagues from CSIRO Marine and Atmospheric Research for their contributions to the Voyages of Discovery research program. We thank Nic Bax for help in securing funds, Rudy Kloser for his part in leadership of the surveys, and Mark Lewis, and Karen Gowlett-Holmes for help with gear and dealing with samples while on board FRV *Southern Surveyor*. We acknowledge the Commonwealth Department of Sustainability, Environment, Water, Population and Communities, and the CSIRO Wealth from Oceans Flagship for financial support and the field and laboratory components of the Voyages of Discovery program. This work has been funded through the National Environmental Research Program (NERP) program, an Australian Government initiative supporting world class, public good research. The NERP Marine Biodiversity Hub is a collaborative partnership between the University of Tasmania, CSIRO Wealth from Oceans Flagship, Geoscience Australia, Australian Institute of Marine Science, Museum Victoria, Charles Darwin University and the University of Western Australia (www.nerpmarine.edu.au). We thank Suzanne Horner, Northern Territory Museum and Art Gallery, Darwin, for facilitating a loan.

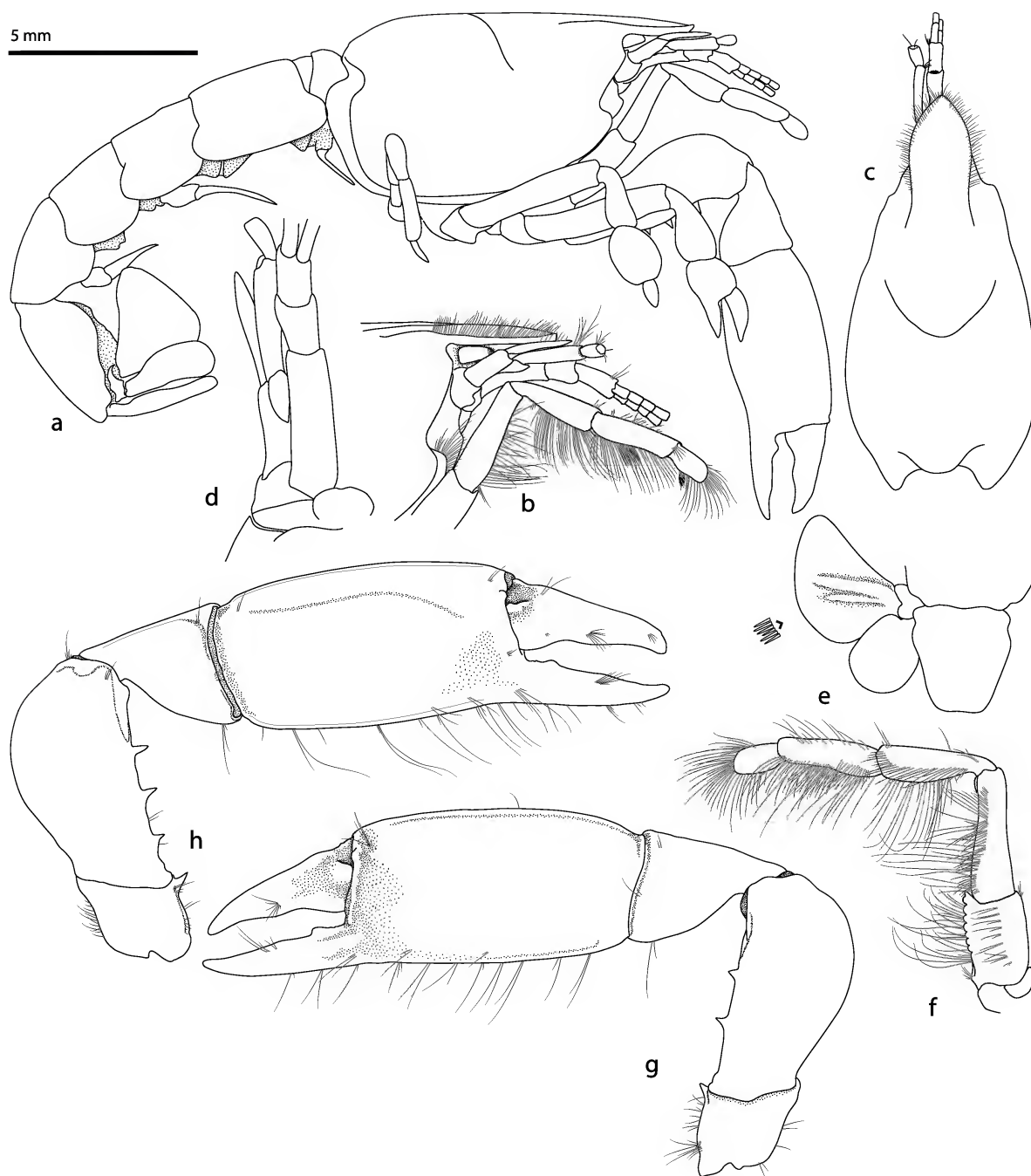


Figure 3. *Tethisea alanwilliamsi* sp. nov. Holotype, NMV J55604. a, habitus. b, c, anterior carapace, antennules, antennae, in lateral and dorsal views. d, antennules, antennae, in ventral view. e, telson (long marginal setae not shown, marginal robust setae in detail) and uropods (marginal setae not shown). f, maxilliped 3. g, h, left and right chelipeds. Scale bar applies to habitus only.

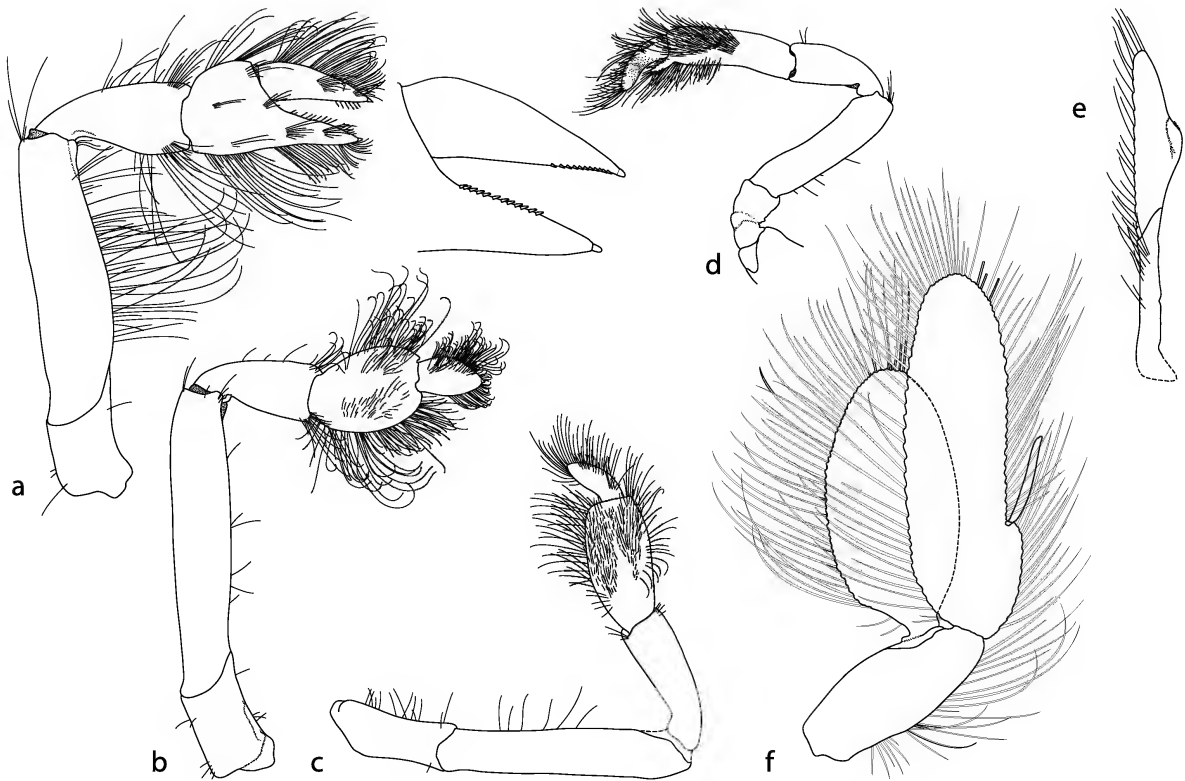


Figure 4. *Tethisea alanwilliamsi* sp. nov. Holotype, NMV J55604. a–d, pereopods 2–5. e, f, male pleopods 1, 3.

References

- Balss, H. 1921. Diagnosen neuer Decapoden aus den Sammlungen der Deutschen Tiefsee-Expedition und der japanischen Ausbeute Dofleins und Haberers. *Zoologischer Anzeiger* 52: 175–178.
- Bouvier, E.L. 1905. Sur les Thalassinidés recueilles par le Blake dans la mer des Antilles et le golfe du Mexique. *Comptes Rendus Hebdomadaires de Séances de l'Académie des Sciences, Paris* 141: 802–806.
- Carvalho, H.A. de, and Rodrigues, S.de A. 1973. *Marcusiavirus lemoscastroi*, g. n., sp. n., nova ocorrência da família Axiidae (Crustacea, Decapoda, Thalassinidea) no Brasil. *Boletim do Zoologia e Biologia Marina, São Paulo*, n.s. 30: 553–566.
- Dworschak, P.C. 2008. *Neocallichirus kemp* Sakai, 1999, a junior synonym of *Callianassa karumba* Poore and Griffin, 1979 (Decapoda: Callianassidae). *Raffles Bulletin of Zoology* 56: 75–84.
- Dworschak, P.C., Felder, D.F., and Tudge, C.C. 2012. Chapter 69. Infraorders Axiidea de Saint Laurent, 1979 and Gebiidea de Saint Laurent, 1979 (formerly known collectively as Thalassinidea). Pp. 109–219 in: Schram, F.R., and von Vaupel Klein, J.C. (eds), *Treatise on Zoology – Anatomy, Taxonomy, Biology. The Crustacea. Complementary to the volumes translated from the French of the Traité de Zoologie [founded by P.-P. Grassé]*. Brill: Leiden.
- Felder, D.L., and Robles, R. 2009. Molecular phylogeny of the family Callianassidae based on preliminary analysis of two mitochondrial genes. Pp. 319–342 in: Martin, J.W., Crandall, K.A., and Felder, D.L. (eds), *Crustacean Issues Vol. 18: Decapod Crustacean Phylogenetics*. CRC Press: Boca Raton.
- Gore, R.H. 1987. *Callianidea vandoverae* species nova (Decapoda, Thalassinidea, Callianideidae) from off the central eastern Florida coast, U. S. A. *Crustaceana* 53: 186–194.
- Kensley, B., and Heard, R.W. 1991. An examination of the shrimp family Callianideidae (Crustacea: Decapoda: Thalassinidea). *Proceedings of the Biological Society of Washington* 104: 493–537.
- Kossmann, R. 1880. Zoologische Ergebnisse einer Reise in die Küstengebiete des Rothen Meeres, volume 2, part 1, section III, Malacostraca. *Zoologische Ergebnisse im Auftrage der königlichen Akademie der Wissenschaften zu Berlin* 1880: 67–140.
- Lin, F.-J. 2006. Two new axioids (Decapoda: Thalassinidea) from New Caledonia. *Journal of Crustacean Biology* 26: 234–241.
- Liu, W., and Liu, J.-Y. 2012. *Michelea takeda* sp. nov. (Crustacea, Decapoda, Axiidea, Micheleidae) from the South China Sea. *Crustaceana Monographs* 17: 175–181.
- Man, J.G. de 1905. Diagnoses of new species of macrurous decapod Crustacea from the “Siboga-Expedition”. *Tijdschrift der Nederlandsche Dierkundige Vereeniging* 9: 587–614.
- McCallum, A.W. 2011. *Decapod crustacean diversity along Australia's western continental margin*. PhD thesis. University of Melbourne: Melbourne. 212 pp.
- Milne Edwards, H. 1837. *Histoire naturelle des crustacés, comprenant l'anatomie, la physiologie et la classification de ces animaux*. Vol. 2. Librairie Encyclopédique de Roret: Paris. 532 pp.
- Poore, G.C.B. 1994. A phylogeny of the families of Thalassinidea (Crustacea: Decapoda) with keys to the families and genera. *Memoirs of the Museum of Victoria* 54: 79–120.

- Poore, G.C.B. 1997. A review of the thalassinidean families Callianideidae Kossmann, Micheleidae Sakai, and Thomassiniidae de Saint Laurent (Crustacea: Decapoda) with descriptions of fifteen new species. *Zoosystema* 19: 345–420.
- Poore, G.C.B. 2004. *Marine decapod Crustacea of southern Australia. A guide to identification (with chapter on Stomatopoda by Shane Ahyong)*. CSIRO Publishing: Melbourne. 574 pp.
- Poore, G.C.B. 2008. Thalassinidean shrimps (Crustacea: Decapoda) from north-western Australia, including five new species. *Records of the Western Australian Museum, Supplement* 73: 161–179.
- Poore, G.C.B. 2015. Rediagnosis of Callianideidae and its genera (Crustacea: Decapoda: Axiidea), and description of a new species of *Heardaxius* Sakai, 2011. *Zootaxa* 3995: 229–240.
- Poore, G.C.B., and Collins, D.J. 2009. Australian Axiidae (Crustacea: Decapoda: Axiidea). *Memoirs of Museum Victoria* 66: 221–287.
- Poore, G.C.B., and Griffin, D.J.G. 1979. The Thalassinidea (Crustacea: Decapoda) of Australia. *Records of the Australian Museum* 32: 217–321.
- Poore, G.C.B., McCallum, A.W., and Taylor, J. 2008. Decapod Crustacea of the continental margin of southwestern and central Western Australia: preliminary identifications of 524 species from FRV Southern Surveyor voyage SS10-2005. *Museum Victoria Science Reports* 11: 1–106.
- Robles, R., Tudge, C.C., Dworschak, P.D., Poore, G.C.B., and Felder, D.L. 2009. Molecular phylogeny of the Thalassinidea based on nuclear and mitochondrial genes. Pp. 309–326 in: Martin, J.W., Crandall, K.A., and Felder, D.L. (eds), *Crustacean Issues Vol. 18: Decapod Crustacean Phylogenetics*. CRC Press: Boca Raton.
- Rodrigues, S.de A., and Carvalho, H.A. de 1972. *Marcusiaxius lemoscastroi*, g. n., sp. n., primeira ocorrência da família Axiidae (Crustacea, Decápoda, Thalassinidea) no Brasil. *Ciência e Cultura, São Paulo. Suplementa* 24: 357.
- Saint Laurent, M. de 1973. Sur la systématique et la phylogénie des Thalassinidea: définition des familles des Callianassidae et des Upogebiidae et diagnose de cinq genres nouveaux. *Comptes Rendus Hebdomadaires de Séances de l'Académie des Sciences, Paris* 277: 513–516.
- Sakai, K. 1984. Some thalassinideans (Decapoda: Crustacea) from Heron Is., Queensland, eastern Australia, and a new species of *Gouretia* from east Africa. *The Beagle, Records of the Northern Territory Museum of Arts and Sciences* 1: 95–108.
- Sakai, K. 1987. Two new Thalassinidea (Crustacea: Decapoda) from Japan, with the biogeographical distribution of the Japanese Thalassinidea. *Bulletin Of Marine Science* 41: 296–308.
- Sakai, K. 1992. The families Callianideidae and Thalassinidae, with the description of two new subfamilies, one new genus and two new species (Decapoda, Thalassinidea). *Naturalists, Publications of Tokushima Biological Laboratory, Shikoku University* 4: 1–33.
- Sakai, K. 2010. Callianassoidea from the Gulf of Tonkin and the Red Sea, in the Zoological Museum of Moscow University (Decapoda, Thalassinidea). *Crustaceana* 83: 1431–1467.
- Sakai, K. 2011. Axiioidea of the world and a reconsideration of the Callianassoidea (Decapoda, Thalassinidea, Callianassida). *Crustaceana Monographs* 13: 1–616.
- Sakai, K. 2014. Axiioidea material collected by the Japanese R/V-S “Hakuhou-Maru” and “Nagasaki-Maru” in the east China Sea with a revised key to the families of the superfamily Axiioidea Huxley, 1879 (Decapoda, Callianassidea). *Crustaceana* 87: 609–626.
- Sakai, K., and Türkay, M. 2012. A collection of Thalassinidea Latreille, 1831 (Decapoda, Pleocyemata) from the Senckenberg Forschungsinstitut and Natural History Museum, Frankfurt am Main. *Crustaceana* 85: 723–765.
- Sakai, K., and Türkay, M. 2014. A review of the collections of the Infraorders Thalassinidea Latreille, 1831 and Callianassidea Dana, 1852 (Decapoda, Pleocyemata) lodged in three German museums, with revised keys to the genera and species. *Crustaceana* 87: 129–211.
- Stebbing, T.R.R. 1920. South African Crustacea, (Part X of S.A. Crustacea, for the Marine Investigations in South Africa). *Annals of the South African Museum* 17: 231–272, pls 218–227.

C. H. McLennan ('Mallee Bird') and his Aboriginal informant Jowley: The source of early records of the Night Parrot *Pezoporus occidentalis* in Victoria?

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Abstract

Menkhurst, P. and Ryan, E. 2015. C. H. McLennan ('Mallee Bird') and his Aboriginal informant Jowley: The source of early records of the Night Parrot *Pezoporus occidentalis* in Victoria? *Memoirs of Museum Victoria* 73: 107–115.

Historical records of the Night Parrot *Pezoporus occidentalis* in north-western Victoria have not always been accepted as valid despite prominent contemporary ornithologists accepting them. We present new supporting information gleaned from newspaper articles written under the pseudonym 'Mallee Bird' published in national and local newspapers in the early 20th century. 'Mallee Bird' was Charles H. McLennan, a bushman and well-regarded ornithologist who worked on pastoral runs established among the terminal lakes of the Wimmera River in the Big Desert of north-western Victoria. We also provide biographical details of a local Aboriginal man, Jowley, identified by McLennan as his informant about the nest site and clutch size of the Night Parrot. We provide evidence that McLennan and Jowley were known to each other and probably worked together on cattle runs in the Hopetoun–Pine Plains region around the turn of the 19th–20th century. McLennan and Jowley's observations of Night Parrot calls, habitat use, breeding and flight are some of the earliest published natural history of this most mysterious of Australian birds. They mostly corroborate other contemporary accounts and concur with preliminary findings of current research on the species in south-west Queensland. The relationship between McLennan and Jowley is one of the few documented Victorian examples of aboriginal information being incorporated into European ornithological knowledge. McLennan's support and encouragement of ornithological expeditions to the Wonga Lake–Pine Plains area was pivotal in having the area declared the first National Park in the Murray Mallee region.

Keywords

Night Parrot, *Pezoporus occidentalis*, historical records, Aboriginal information, Wimmera District, Mallee region, Victoria

Introduction

The Night Parrot *Pezoporus occidentalis* is one of the most mysterious of Australia's vertebrates. Few confirmed sightings of the species were made during the 20th century, and none involved repeat sightings at a single locality. There are only 24 Night Parrot specimens in the world's museums (Forshaw et al. 1976), the two most recent resulting from the chance finding of corpses beside roads in south-west Queensland (Boles et al. 1994; McDougall et al. 2009). In July 2013, renowned bushman John Young revealed the first ever photographs of a Night Parrot taken at an undisclosed location in south-west Queensland. Young's discovery has provided the first opportunity for field study of this elusive species since the work of F.W. Andrews in the 1870s (Andrews 1883; Murphy 2013, 2015; Pyke and Ehrlich 2014).

In the late 19th and early 20th centuries, finding the Night Parrot appears to have been something of a focus of Victorian ornithologists (see below). However, the basis of the belief that

the species was, or had been, present in north-western Victoria has never been clear, perhaps leading some Victorian authorities to discount the records. The Night Parrot was not included in a list of Victorian bird species published in 1884 (Forbes-Leith and Campbell 1884), or in a list of additions and emendations published a decade later (Anon 1894). The first published record of the presence of the Night Parrot in Victoria is Campbell (1897), and the species was recognized as part of the Victorian fauna in 1908 (Leach no date). Leach (1911) also listed Victoria as being within the Night Parrot's distribution, however, reference to Victoria was dropped from later editions of Leach's book that were edited by Charles Barrett. McKean (1959) relegated the species to a list of 'Doubtful and erroneous records', as did Wheeler (1967, page 77) and it was not mentioned by Harold Tarr in a published list of the birds of Wyperfeld National Park that he prepared for the Victorian National Parks Authority (Tarr 1967). However, as pointed out by Forshaw (1969, 1970), records from adjacent parts of South Australia and New South Wales provide support for the presence of the Night

Parrot in the region in the late 19th century, and Emison et al. (1987) reinstated the species to the Victorian faunal list.

While records based on historical sightings can arguably never be fully verified, an examination of the historical setting and biographical details of the observer(s) can provide important anecdotal information and supplementary evidence to inform decisions about the veracity of historical records.

Here we discuss newspaper articles published in 1908 and 1913 that shed light on the origin of reports of the Night Parrot in the region of the terminal lakes of the Wimmera River in north-western Victoria. We provide brief biographies of the key observers and correspondents and reassess the historical significance of the Victorian observations of this mysterious species. We also highlight another newspaper article that provides an insight into the intensity of survey for the Night Parrot in north-western Victoria in the early 20th century.

Methods

We searched the natural history and ornithological literature for records of the Night Parrot in Victoria. In addition, the recent availability of searchable pdf files of the pages of local newspapers and magazines from throughout Australia (Trove database, National Library of Australia website) has made this largely untapped source of historical wildlife observations easily accessible to the ecological historian (Abbott 2008). We used Trove to search for mentions of the Night Parrot in Victoria by searching on the key words 'Night Parrot' and 'Night Parakeet'. We also examined the archives of the Royal Australasian Ornithologists Union (RAOU), held in the State Library of Victoria, and consulted publications on the history of the RAOU (Dickison 1932, 1951; Robin 2001) in an attempt to ascertain whether the search for the Night Parrot in Victoria was a formal project of that organization.

We also utilised Trove to search for biographical materials on Charles McLennan and on a local Aboriginal man, Jowley, who provided details of Night Parrot natural history to McLennan. However, the biographical background of Jowley was mostly elucidated from genealogical records located as part of Ryan's ongoing doctoral research on relations between Aboriginal and European people in north-western Victoria in the colonial period.

Results

Natural history journals

The eight reports of the Night Parrot in north-western Victoria during the late 19th and early 20th centuries all involve second-hand, anecdotal information. Only two of them provide any details about the provenance and location of the records and six of them seem to refer to the same un-named source. Relevant parts of these eight published reports are transcribed below, in chronological sequence.

Campbell (1897):

'Night Parakeet (*Geopsittacus occidentalis*)

It has been reported that this remarkable parrot has been seen in the Mallee. Whether it has always existed in that

locality, or whether it has been driven there by the recent severe drought experienced in its more central domains, is a matter for conjecture.'

Campbell (1901 p 660):

'the bird has been observed in the Wimmera district, Victoria, where it was reported a nest containing five eggs was found in some porcupine grass.'

French (1901):

'The rare Night Parakeet, *Geopsittacus occidentalis*, exists here but we were unable to find any specimens.'

Mattingley (1909):

'The Night Parrot, *Geopsittacus occidentalis*, used to be seen by the aborigines at Wonga years ago. It lays five to six eggs in the spinifex.'

Howe and Tregellas (1914):

'Our primary object was to obtain skins of the Night-Parrot (*Geopsittacus occidentalis*). It is supposed that this form is nearly extinct, but Mr. Scarce has met it twice, in different localities, some 70 miles apart – a few miles further north than we reached in September, and again some 12 miles south of Kow Plains.

Campbell (1915):

'Night-Parrot (*Geopsittacus occidentalis*). – Being a nocturnal species, this Parrot was always scarce, or was rarely seen, although its habitat extended from North-West Victoria to North-West Australia.' '...while we know that Victorian field observers, during excursions to the north-west corner of their State, which the Night-Parrot used to frequent, also failed to trace it.'

Howe (1933):

Recounts that in September 1913 Mr J. J. Scarce 'paid a visit to a certain spot some ten miles north-west of Bell-Bird to have a look for the Night Parrot (*Geopsittacus occidentalis*).' ['Bell-Bird' is Bellbird Bore, located near the junction of Bellbird Bore Road and Rockhole Road (34°54' 22" S; 141° 02'32" E) at the south-west edge of the Sunset Country].

Campbell, A.G. (1934):

A.J. Campbell's son, A.G. Campbell, repeated the Wimmera River nest record: 'The Night Parrot (*Geopsittacus occidentalis*), the eggs of which were seen many years ago in a belt of spinifex on the Wimmera River, Victoria, and which has not been recorded in that State for many years, is known on the spinifex fringe of the western mallee.'

Trove database

Our search of the Trove database revealed a further five references to the Night Parrot in north-western Victoria. The first is another vague reference by A.J. Campbell to the presence of the species in the Wimmera District (Campbell 1898) and it is not considered further here. The other four provide new and interesting information: three were written by 'Mallee Bird', and the fourth refers to an expedition to north-western Victoria aimed at collecting specimens of the Night Parrot.

'Mallee Bird' was the pseudonym of Charles H. McLennan [sometimes rendered M'Lennan] (1854-1915), a regular contributor of natural history articles to newspapers and magazines in the early 20th century (Howe 1909; Mattingley 1909; Whittell 1954; Kloot 1995), including long articles in *The Australasian* and various regional newspapers, as well as contributions to Donald MacDonald's 'Nature Notes' in *The Argus* newspaper. During the 1890s and early 1900s, McLennan worked as a farmhand and dingo trapper on isolated and short-lived sheep and cattle runs that had been established on the system of usually-dry lake beds at the termination of the Wimmera River, surrounded by the extensive sand dune country carrying mallee heath vegetation known as the Big Desert. Based on his writings, McLennan travelled widely through north-western Victoria, on horseback and on foot, including north through the Sunset Country to the Murray River and south through settled districts to the Horsham area.

McLennan's Night Parrot reports

Between April 1908 and August 1913, McLennan published three articles that mention the Night Parrot in the context of north-western Victoria, including both the Big Desert (Pine Plains) and the Sunset Country (Koorlong Tank). Here we reproduce in full and in chronological sequence, the paragraphs concerning the Night Parrot.

Mallee Bird (1908):

'One of the most interesting of the birds that haunts the spinifex tracts in Sunset country is the now rare night parrot, whose plaintive whistling note heard in the still of the night makes one in a sense of his solitude. They are unfortunately becoming extinct. Some years ago hundreds of domestic cats were turned loose in the Mallee, in the hope that they would kill off the rabbits. They evidently preferred a bird diet and the night parrots, occupying in day time old rabbit burrows, fell easy prey to them. The ever increasing fox is another enemy, and when I find feathers or remains of the night parrot there are generally fox or cat traces in the loose soil. On the wing the night parrot takes short, quick flights, dropping suddenly like a snipe. According to Jowley, an old aboriginal of this district, they live in a tussock of turpentine grass and lay from four to six eggs, rather round in shape'.

Mallee Bird (1913a):

'Where hundreds of acres are covered with a 6 ft growth of dense spinifex, the queer night parrot has its home. You hear his strange whistling cry at night, and so look for him by day.'

Mallee Bird (1913b):

'This bird, as its name implies, is nocturnal in its habits. The tall dense spinifex grass is where this strange bird makes its home and often throughout the night it utters a plaintive whistling cry. Between thirty and forty years ago [i.e. roughly 1873-1883] they were found in the spinifex grass on the sand ridges around Pine Plains. The last I saw of the birds was some eight years ago [i.e. approx. 1905], between Sunset Country and Koorlong [Koorlong is a

locality west of Red Cliffs and south-west of Mildura, south of Mildura airport]. Of late years the bird has become somewhat of a 'rara avis', mainly through the liberation in the mallee of many hundreds of domestic cats to combat against the rabbits. So far as the rabbit was concerned the cat was a failure, pussy being too good an epicure to dine on bunny while birds were so easily caught and were more to her taste. And now, of late years, the fox coming on the scene, I am afraid that the parrot is almost extinct in these parts. Being terrestrial in their habits they are a difficult bird to flush in the daytime without the aid of a good dog. So far I have not heard of the nest being found, but the information I received from the old men aboriginals was that the birds build their nests in the dense spinifex grass. The plumage on the upper part is olive green, the head and neck have a black speck in the middle of each feather. The breast is olive green, with black spots and irregular bands, the abdomen and under tail coverts sulphur-yellow. Plump in structure and short tail, toe-nails short and curved.'

We are able to date the first realization by Victorian ornithologists that the Night Parrot occurred within that State as sometime in the three years between the publications of Anon (1894), which made no mention of the species, and Campbell (1897) which included it. We do not know when McLennan discussed the Night Parrot with Jowley (see McLennan 1908) and presumably with other 'old men aboriginals' but McLennan (1913b) indicates that the timing of the sightings at Pine Plains was sometime in the 1870s to early 1880s. McLennan's last claimed sighting was in approximately 1905, north of the Sunset Country towards Koorlong Tank.

Scarce's Night Parrot observations

The second set of Night Parrot reports are those of Mr J. J. Scarce (in Howe and Tregellas 1914). These relate to entirely different locations to those of McLennan, one in the northern Big Desert, 65 km wnw of Wonga Lake, the other ~ 70 km further north again in the Sunset Country. From 1908 to 1914, J. J. Scarce led a Victorian Government bore sinking team in the unsurveyed northern portion of the Victorian border lands, searching for sources of ground water that would allow further agricultural development. In so doing, his party lived for extended periods deep in the mallee, far from settled regions (Howe and Tregellas 1914). He reported Night Parrots at two locations; the first 'about 42 miles [65 km] north of Murrayville near the South Australian border', and the second '12 miles [19 km] south of Kow Plains' [also known as Cow Plains, the homestead is at the present-day township of Cowangie, 20 km east of Murrayville].

Scarce's descriptions of the behaviour and habitat preferences of the birds are entirely plausible for the Night Parrot:

'In both instances the birds were in thick and large porcupine grass (*Triodia*), and were seen feeding out on the edges of the grass, in each case where the grass spreads out on to small plains. There were round burrows right through each clump, and Mr Scarce supposed that these were made by the birds as a means of escape.'

Expeditions by Melbourne-based ornithologists

The reports of both McLennan and Scarce stimulated expeditions by ornithologists keen to obtain specimens or photographs of the Night Parrot (French 1901; Howe 1909; Mattingley 1909; Howe and Tregellas 1914). Anon (1917) refers to a party of RAOU members setting off on an expedition in search of the Night Parrot, apparently the eighth such expedition in eight years (i.e. 1910-1917):

'Today Mr H. A. Purnell will leave Geelong to join with four other members of the Royal Australian Ornithologists Union for a fortnight's encampment in the mallee. Their destination is Kow Plains, which is reached by train to Boinka, then by vehicle through the mallee. Mr Purnell is taking with him 200 slides to secure pictures of bird life. The main object of the party's visit is to try to discover a specimen of the night parrot. Opinions differ as to whether this bird is extinct. It is fifty years since Gould discovered it¹, and there is no authenticated record of one being seen since. For seven years the union has had a party in the Mallee in quest of the bird, and this year they are to make another attempt.'

Presumably, these annual expeditions are the unsuccessful searches referred to by Howe and Tregellas (1914). Campbell (1915) states that 'Victorian field observers, during excursions to the north-west corner of their State, which the Night-Parrot used to frequent, also failed to trace it.'

RAOU archives

A search of the RAOU archives held in the State Library of Victoria (La Trobe Australian Manuscripts Collection MS11437), and the literature (Dickinson 1932, 1951; Robin 2001) failed to trace any mention of these expeditions, suggesting that they were privately organized and not official RAOU business.

Discussion

The first five reports of the Night Parrot in Victoria in the natural history literature (Campbell 1897, 1898, 1901; French 1901; Mattingley 1909) appear to refer to the same undisclosed source and to the localities 'Wonga, and Wimmera District'. Wonga and Wonga Lake are well-known features of the lower Wimmera River system in the Big Desert (now within Wyperfeld National Park). The reference to the Wimmera district (Campbell 1901) likely refers to the same reports and location, but the author may be using the term in the contemporary sense of the Wimmera Pastoral District which extended from the Grampians Ranges in the south to the Murray River in the north, encompassing most of north-western Victoria. The Wimmera River passes through about half of this region on its way to its ephemeral terminal lake system in the Big Desert, of which Wonga Lake is part. This lack of understanding of contemporary district nomenclature

could also be responsible for some later authors dismissing the Victorian Night Parrot records because the notion of Night Parrots breeding in the Wimmera District as it is now defined (as distinct from the Mallee District), seems less plausible than in the Big Desert. These 'Wimmera' records were, however, accepted in the RAOU's historical atlas (Blakers et al. 1984 p. 665) but were mapped using the modern definition of the Wimmera and are therefore placed approximately one degree of latitude too far south. Having said that, prior to large-scale land clearing, fingers of Mallee scrub ran southwards into what is now known as the Wimmera District, as far south as Dimboola (Everett 1869). It is these southern Mallee outliers that were visited by Campbell (1885) – they were easily accessible to Melbourne-based ornithologists because they were close to the Melbourne-Adelaide railway.

McLennan worked on pastoral runs in this region including Pine Plains Station, centred on Wirrengrren Plain, and Wonga Lake Station to the south in the Lake Brambruk-Wonga Lake area (French 1901). Wonga Lake Station originally formed part of a larger Pine Plains run and after the subdivision both runs had common owners at times and drew on the same pool of rural labourers. At the turn of the 20th century both these stations were leased by Mr S. Poulton (Kenyon 1914, page 146) who employed McLennan as a dingo trapper amongst other duties (French 1901). Poulton's 'home' station was Cambacanya Station to the east and some 10 miles (16 km) north of the township of Hopetoun (Kenyon 1914). By this period, McLennan had worked in the remote areas of north-west Victoria for many years. In 1900, on his volunteering for the Boer War Bushmen's Corps, he was praised in the Horsham Times as 'an all round bushman' (Anon 1900). In earlier years, McLennan was a noted athlete and played football for Norwood in South Australia before pursuing his bush life from a family base at Horsham (Anon 1915).

Around the turn of the 20th century, several notable Melbourne ornithologists made expeditions to the Big Desert region in search of rare and little-known birds and their eggs. Often, they travelled by train to Hopetoun, to which the railway had been extended in 1894. Here they were met by Poulton and taken by horse and cart to Wonga Lake Station where McLennan acted as a host and guide in this isolated and inhospitable country (see for example Mattingley 1909). A sketch map of the country between Hopetoun and Pine Plains prepared by McLennan for his visitors is held by the State Library of Victoria and is reproduced in Durham (2001, page 24). In September 1908, McLennan met F.E. Howe and J.A. Ross at Pinnaroo, South Australia, to lead them on a collecting trip to Kow Plains (Howe 1909). Mattingley (1932) notes that his first journey to Pine Plains came at the invitation of Charles McLennan². He also states that these expeditions had such an effect on himself and his companions that they began to campaign to have the area around Pine Plains declared a National Park, and this was achieved in 1909 (Durham 2001).

¹ Gould did not discover the Night Parrot, it was first collected by the explorer John MacDouall Stuart in 1845; Gould described the species in 1861 using a specimen collected in 1854 near Mt Farmer, WA as the type specimen (Gould 1861).

² It was presumably through these contacts that McLennan was appointed the first ranger at Victoria's first National Park at Wilson's Promontory in 1909, before clashing with park management and returning to the Mallee at the end of 1910.

A further link between Victorian ornithologists and the Hopetoun region is the fact that J.A. Leach was the teacher at Goyura, 10 km south-east of Hopetoun, in the early 1890s (Whittell 1954; Taylor 1996). Leach likely became acquainted with McLennan, and possibly Jowley, at this time, and could have heard of the Night Parrot sightings directly from them. Leach later made an important contribution to the Royal Australasian Ornithologists Union, being Editor of *The Emu* from 1914 to 1924 and Chairman of the committee that produced the second Checklist of Australian Birds (Whittell 1954).

Regardless of this early enthusiasm for finding the Night Parrot in the Wonga Lake area, by 1918 the prevailing opinion seems to have been that the Night Parrot was no longer present in the region (Campbell 1915; Mattingley 1918). Indeed, Mathews (1917) had declared the species extinct. In 1933, however, an expedition of 'eight well known men' led by A.S. Kenyon started a search for the Night Parrot which was to encompass Alice Springs, western Queensland and Birdsville, by striking west through the Mallee country from Ouyen (Anon 1933). Even at this late date it seems that what was a serious and large-scale hunt for the bird could not ignore the Victorian Mallee completely.

McLennan's notes provide compelling evidence that he did have personal field experience of the Night Parrot. Indeed, his notes are among the first published observations of the natural history of the species, being preceded only by Andrews (1883). Key elements of Night Parrot morphology, behavior and habitat mentioned by McLennan include:

1. His description of plumage and body structure (Mallee Bird 1913b) is detailed, perceptive and accurate, highlighting key identification features, as seen by a field observer, rather than the detailed plumage descriptions usually provided by museum-based ornithologists, or artists working from dead specimens. He claims to have found feathers and remains of Night Parrots (Mallee Bird 1908)³ and this could account for his detailed understanding of plumage colour patterns. It is also possible that McLennan had examined a museum specimen of a Night Parrot and that this could have influenced his description of the external morphology of the species. The first of three specimens of the Night Parrot in Museum Victoria was accessioned into the collection in July 1876⁴ and so would have been available to McLennan had he wished to examine it. The relevant curator during McLennan's time was J.A. Kershaw, Curator of the Zoological Collection 1899-1913 (Whittell 1954; McEvey 1975), and active in the RAOU at the time. McLennan certainly had indirect contact with Kershaw as he sent a *Phascogale* skin to the Museum for identification in 1905. Given his reference to finding 'feathers or remains' (Mallee Bird 1908), however,

viewing a specimen at the Museum would largely have served to confirm his previous field knowledge of the bird.

2. McLennan's descriptions of the habitat preference – 'where hundreds of acres are covered with a 6 foot growth of dense spinifex' (Mallee Bird 1913a), and 'the tall, dense spinifex grass is where this strange bird makes its home' (Mallee Bird 1913b) – broadly concur with other published accounts in highlighting the importance of *Triodia* as a daytime refuge and food source.
3. The descriptions of the nest and eggs provided by the local aboriginals concur with those of other observers, and were preceded only by Andrews (1883) and Keartland (in North 1898).
4. McLennan's descriptions of the call – 'plaintive whistling note heard in the still of the night' (Mallee Bird 1908), 'you hear his strange whistling cry at night' (Mallee Bird 1913a), 'often throughout the night it utters a plaintive whistling cry' (Mallee Bird 1913b) – fit well with other published descriptions: 'a long drawn-out mournful whistle' (Bourgoin in Wilson 1937); 'a sweet, low, two-tone whistle' (McDonald in Wilson 1937). The only person to have closely studied Night Parrot vocalisations, Dr S. Murphy, when asked to comment on McLennan's description of the call stated (S. Murphy in lit. 11 March 2015) 'I think 'plaintive' is a good word to describe the two-note call, and his description does not contradict anything I know to be true'. Murphy also confirmed that Night Parrots do, under certain circumstances, call many times throughout the night (Murphy 2015). McLennan's descriptions are, in fact, the first published to provide any level of detail about the whistle call of the Night Parrot, and therefore could not be repetition of earlier published reports. Only three descriptions of Night Parrot vocalisations were published before McLennan's: the first describes calls given by a captive Night Parrot held in London Zoological Gardens for a short time in 1867 and early 1868 (Murie 1868) – a 'double note, harsh and loud' and a 'faint whistle'; the second refers to a 'whistling note' said to be onomatopoeic with an aboriginal word for the species – 'Myrrlumbing' (Andrews 1883) and to a 'very peculiar croaking note of alarm whilst at the water, which much resembles the loud croak of a frog.'; the third refers to what is presumably an alarm call given when flushed – 'a short sharp note given several times as they go' (Keartland in North 1898 page 171).
5. It is clear from his reference to the flight of the Night Parrot (Mallee Bird 1908) that he was not merely familiar with its 'feathers and remains' but also its flight behaviour – 'On the wing the night parrot takes short, quick flights, dropping suddenly like a snipe'. This observation is corroborated by other observers (North 1898; McGilp 1931; Kershaw 1943; S. Murphy pers comm). It is also similar to the flight behavior of the other member of the genus *Pezoporus*, the Ground Parrot (Menkhurst pers obs).

We suggest that the reports of the Night Parrot from the terminal lakes of the Wimmera River system (but not those of Scarce) all emanate from this one source – McLennan's observations in the last decades of the 19th century and first

3 As have Murphy and Young at the south-west Queensland site (pers comm.)

4 This specimen was collected by F.W. Andrews during the 1875 Lake Eyre Expedition conducted by the South Australian Museum. It was sent by F.G. Waterhouse, Curator of the South Australian Museum, to the National Museum of Victoria in exchange for a pair of Blue-billed Ducks! (Forshaw et al. 1976)

decade of the 20th century, combined with information gleaned from his conversations with elderly aboriginal men from the region, including Jowley. In particular, it seems that the aboriginal men were the source of McLennan's information on nesting site and clutch size. It seems reasonable to assume that the source for Mattingley's (1909) reference to sightings by aboriginals in the Wonga Lake area is the same as McLennan's specific reference to Jowley and general reference to 'old men aboriginals'. Because it was McLennan who lived and worked in the local area, he is most likely to have been the person who gained the information first hand from the aboriginals. Jowley is known to have lived for a period in a hut at Wonga (Taylor 1996) and so would have been well known to McLennan. Indeed, Taylor (1996) refers to a report of a weekend horseback excursion to Wonga by seven Hopetoun residents led by 'the Mallee bushman and ornithologist Charles McLennan' which encountered Jowley (and his cattle).

Howe (1933) provides a lead to the possible location of Scarce's northernmost observation, previously described as 'about 42 miles north of Murrayville near the South Australian border' (Howe and Tregellas 1914). Howe (1933) relates that shortly after 20 September 1913, after Howe and Tregellas had left Scarce's camp to return to Melbourne, Scarce made a specific visit to a 'spot some 10 miles north-west of Bell-Bird to have a look for the Night Parrot (*Geopsittacus occidentalis*). It is plausible that this spot was the location of Scarce's earlier observation – it fits with the statement in Howe and Tregellas (1914) that the site was 'a few miles further north than we reached in September' [1913]. If so, its whereabouts can be more precisely defined – 'Bell-Bird' is Bellbird Bore, located in what is now Berook State Forest near the junction of Bellbird Bore Road and Rockhole Road (34°54' 22" S; 141° 02' 32" E). It seems likely that this was the campsite used by Scarce's Government boring party and visited by Howe and Tregellas. Ten miles north-west of Bellbird Bore is roughly at 34° 47' S; 141° 02' E, assuming Scarce's 'spot' was in Victoria, as implied by Howe and Tregellas (1914). This location is about 57 km nnw of Murrayville, compared to the estimate of Howe and Tregellas (1914) of 65 km (42 miles) north of Murrayville and within 4.8 km (3 miles) of the South Australian border.

Also known as Peter McGinnis, named for one of the squatters who established the Lake Corrong run, Jowley (?-1911) (Fig 1) is a comparatively well-known Aboriginal from the Yarrikuluk clan of the Wergaia language group which inhabited the Hopetoun region. His home country came from his father Mircham, known to Europeans as Tom, while he would also have been familiar with his mother Biddy's country of Morton Plains. His knowledge of country extended to the west Wimmera district of Benyeo, home country of his first wife Eliza, and south-west across the South Australian border to Mosquito Plains, from whence he brought his daughter to the Ebenezer Mission at Antwerp in 1867 (Hartmann and Hartmann 1864-1873). Jowley would have also visited his second wife Esther's country at Lalbert in the south-east Mallee. As parts of each of these areas originally supported spinifex mallee, Jowley may have had multiple opportunities to observe the Night Parrot over many years.

Beyond his personal direct experience, Jowley spent extended periods of time at Ebenezer Mission with other Aboriginals from the region. McLennan may have encountered Jowley when they both worked on local pastoral stations, or he may have met him at Ebenezer as he would have passed it regularly on visits to his family at Horsham.

Ebenezer Mission was visited by members of the Field Naturalists Club in the 1890s (Le Souef 1893), including some who would later search for the Night Parrot with McLennan. It was also visited in the 1890s by ethnographer R. H. Mathews (Mathews, R.H. no date). While Mathews' notes on his visit include the Aboriginal names of many birds and animals, they do not include any reference to the Night Parrot, suggesting that he, as with the field naturalists, was not at the time aware of it in the region. These visits do suggest, however, an exploration of traditional Aboriginal knowledge by developing European sciences, an exploration pursued in a more intimate manner by the contact and discussions between Charles McLennan and Jowley. While they set the scene for the pursuit of the Night Parrot in Victoria in the early years of the twentieth century, these interactions also provided the basis for the broader development of ornithology in Australia as Charles McLennan became an important contributor to the publication of the seminal 'Birds of Australia' by Gregory M. Mathews (Mathews 1910-1927) (Anon. 1915), son of the aforementioned visitor to Ebenezer Mission, R. H. Mathews. McLennan was also the first to record another cryptic mallee bird when, in April 1906, he drew attention to the presence of emu-wrens in the *Triodia* mallee of the Pine Plains area (MacDonald 1906, Howe 1933). At the request of A.J. Campbell, McLennan collected a male which became the type specimen of the newly described Mallee Emu-wren *Stipiturus mallee* (Campbell 1908).

McLennan was an early member of the Royal Australian Ornithologists Union (RAOU archives) and was likely to have conveyed his Night Parrot information to fellow members during visits to Melbourne. For example, McLennan was present at a reception held for G. M. Mathews at the Royal Botanic Gardens, Melbourne, by the RAOU Council on 10 March 1914 (minutes of 100th meeting of Council of RAOU) (Fig 2). This reception was also attended by others who feature in this story including A. J. Campbell, L. G. Chandler, Dr J. A. Leach and T. Tregellas.

McLennan's reports seem to have been widely accepted by his contemporaries, including A. J. Campbell (1897, 1901, 1915), French (1901), Howe and Tregellas (1914), Mattingley (1909), Leach (1908, 1911) and A. G. Campbell (1934). Further, his reports led to a series of expeditions to the terminal lakes of the Wimmera River during the first decade of the 20th century aimed at locating the species and collecting specimens of it. These expeditions provided the initial impetus for the campaign to have the Wonga Lake – Pine Plains area declared a National Park.

In the second decade of the 20th century, the reports by Scarce led to the focus shifting further north to the Kow Plains area where a party of birders apparently searched annually during spring of the years 1910 to 1917 (Anon 1917). Howe and Tregellas mounted a more determined expedition and accompanied Scarce to the sites of his observations in the far

west of the Sunset Country. Their comments (Howe and Tregellas 1914) indicate that Scarce was an astute and knowledgeable bird observer who was able to direct Howe and Tregellas to sites where they could collect sought-after species such as Chestnut Quail-thrush, Shy Heathwren and Southern Scrub-robin. Further, at around the same time, White (1913) reported a sighting of the Night Parrot at Brown's Well, South Australia. This locality, near the present-day town of Paruna, is only 'about 22 km west of Scarce's 'spot' 10 km north-west of Bellbird Bore. We see no reason to question the validity of Scarce's Night Parrot observations, despite the lack of a voucher specimen, which Mathews (1917) regarded as necessary before adding Victoria to its distribution. Of note is the close proximity of Scarce's early-20th century observation '12 miles (19 km) south of Kow Plains' with the mid-20th century reports of Evan Walton of Walpeup at Ross Spring, some 12 km south-east of Kow Plains homestead (Menkhurst and Isles 1981).

We believe that the evidence collated here strongly supports the presence of the Night Parrot in both the Big Desert and Sunset Country of north-western Victoria between the 1870s and early 1900s. We also show that reports of the Night Parrot in this region were instrumental in the development of ornithology in the region, and in the development of the current extensive conservation reserve system in the Victorian Mallee.

Acknowledgements

We thank Dr Penny Olsen for generously sharing her historical research into the Night Parrot. Dr Steve Murphy generously shared his unique field observations and data on vocalisations of the Night Parrot. Kym Schramm of Parks Victoria advised on the precise location of Bellbird Bore. Dr K. Smith, Museum Victoria, kindly provided information on Night Parrot skins held by that institution. Michael Silver prepared the digital version of Figure 2 from a photograph in the L.G. Chandler collection and its publication was kindly approved by Mary Chandler. Phil Taylor generously provided a scan of the portrait of Jowley. Andrew Bennett, Richard Loyn (as referee), Penny Olsen, Andrew Isles and Craig Morley helped improve an earlier draft of the manuscript.

References

- Abbott I. 2008. Historical perspectives of the ecology of some conspicuous vertebrate species in south-west Western Australia. *Conservation Science Western Australia* 6(3): 1–214.
- Andrews, F.W. 1883. Notes on the Night Parrot (*Geopsittacus occidentalis*). *Transactions of the Royal Society of South Australia* 6: 29–30.
- Anon. 1894. The list of Victorian birds. *Victorian Naturalist* XI: 55–56.
- Anon. 1900. Untitled. The Horsham Times, 26 January 1900, p.2.
- Anon. 1915. Death of Mallee Bird. Dimboola Banner, Friday 17 December 1915, page 3.
- Anon. 1917. Have you ever seen the Night Parrot? Geelong Advertiser, Tuesday 11 September 1917, page 2.
- Anon. 1933. Inland Tour. The Courier-Mail. Tuesday 3 October 1933, page 7.
- Blakers, M., Davies, S.J.J.F. and Reilly, P.N. 1984. *The Atlas of Australian Birds*. Royal Australasian Ornithologists Union, Melbourne.
- Boles, W.E., Longmore, N.W. and Thompson, M.C. 1994. A recent specimen of the Night Parrot *Geopsittacus occidentalis*. *Emu* 94: 37–40.
- Campbell, A.G. 1934. The mallee quota of bird life. *Emu* 33: 195–202.
- Campbell, A.J. 1885. Bird Life in the Mallee I. The Australasian, Saturday 2 May 1885, pages 43–44.
- Campbell, A.J. 1897. Ornithological Notes. *Victorian Naturalist* 14: 91–92.
- Campbell, A.J. 1898. Some Australian Birds. The Parrot Family (concluded). The Australasian, Saturday 27 August 1898, page 31.
- Campbell, A.J. 1901. *Nests and Eggs of Australian Birds*. Sheffield England, the author.
- Campbell, A.J. 1908. Description of a new Emu-Wren *Emu* 8: 34–35.
- Campbell, A.J. 1915. Missing Birds. *Emu* 14: 167–168.
- Dickison, D.J. 1932. History and early records of ornithology in Victoria. *Emu* 31: 175–196.
- Dickison, D.J. 1951. The first fifty years of the Royal Australasian Ornithologists Union. *Emu* 51: 184–284.
- Durham, G. 2001. *Wyperfeld: Australia's first mallee national park*. Friends of Wyperfeld National Park Inc., Elsternwick, Victoria.
- Emison, W.B., Beardsell, C.M., Norman, F.I. and Loyn, R.H. 1987. *Atlas of Victorian Birds*. Department of Conservation, Forests and Lands and Royal Australasian Ornithologists Union, Melbourne.
- Everett, A. 1869. Victorian Forest Trees. Map compiled by Arthur Everett for the State Forest Board. State Library of Victoria Map Collection.
- Forbes-Leith, T.A. and Campbell, A.J. 1884. Victorian fauna Class II. Aves-birds. *Victorian Naturalist* 1: 64–68, 74–79.
- Forshaw, J.M. 1969. *Australian Parrots*. Lansdowne Press, Melbourne.
- Forshaw, J.M. 1970. Early record of the Night Parrot in New South Wales. *Emu* 70: 34.
- Forshaw, J.M., Fullagar, P.J. and Harris, J.I. 1976. Specimens of the Night Parrot in museums throughout the world. *Emu* 76: 120–126.
- French, C. Junior. 1901. A naturalist in the mallee. *Victorian Naturalist* 18: 8–14.
- Gould, J. 1861. On a new genus and species of parakeet from Western Australia. *Proceedings of the Royal Zoological Society of London* 1861: 100–101.
- Hartmann, A. and Hartmann M. *Diary 1864–1873*. Moravian Archives, Bethlehem, Pennsylvania, USA.
- Howe, F.E. 1909. Among the birds of north-western Victoria. *Emu* 8: 130–138.
- Howe, F.E. 1933. The Mallee Emu-Wren (*Stipiturus mallee*). *Emu* 32: 266–269.
- Howe, F.E. and Tregellas, T.H. 1914. Rarer birds of the mallee. *Emu* 14: 71–84.
- Kenyon, A.S. 1914. The story of the Mallee. Part II Settlement – the squatters. *Victorian Historical Magazine* 4: 23–74.
- Kershaw, J.A. 1943. Concerning a rare parrot. *Victorian Naturalist* 59: 196.
- Klout, T. 1995. *Whittell (1618–1950) Supplemented: additions and emendations to H.M. Whittell's The Literature of Australian Birds*. Bird Observers Club of Australia, Melbourne.
- Leach, J.A. no date [1908]. Nature Study. A Descriptive List of the Birds Native to Victoria, Australia. *Circular of Information – No. 12*. Education Department, Melbourne.
- Leach, J.A. 1911. *An Australian Bird Book*. Whitcombe and Tombs, Melbourne.
- Le Souef, D. 1893. Notes on a visit to the Ebenezer Mission Station. *Victorian Naturalist* 10: 123–128.
- MacDonald, D. 1906. Nature Notes and Queries, Emu-Wrens in the mallee. The Argus 27 April 1906, page 7.
- Mallee Bird [C. McLennan] 1908. A trip to Sunset. The Australasian, Saturday 4 April 1908, page 52.

- Mallee Bird [C. McLennan] 1913a. Life of the spinifex. The Australasian, Saturday 18 January 1913, page 50.
- Mallee Bird [C. McLennan] 1913b. Mildura District Birds: Owls, Nightjars, Podargus and Night Parrot. The Mildura Cultivator, 23 August 1913 page 13.
- Mathews, G.M. 1910-1927. *The Birds of Australia*. The author, London.
- Mathews, G.M. 1917. Spinifex Parrot or Night Parrot. Pages 495-498 in *The Birds of Australia, Volume 6*. The author, London.
- Mathews, R.H. no date. R.H. Mathews Papers. Ms 8006, National Library of Australia, Canberra.
- Mattingley, A.H.E. 1909. In the heart of the Mallee. *Victorian Naturalist* 26: 68-70.
- Mattingley, A.H.E. 1918. The Ground Parrot. *Leader* (Melbourne), 6 July 1918, page 26.
- Mattingley, A. 1932. Wyperfeld National Park. *Emu* 31: 267.
- McDougall, A., Porter, G., Mostert, M., Cupitt, R., Cupitt, S., Joseph, L., Murphy, S., Janetzki, H., Gallagher, A. and Burbidge, A. 2009. Another piece in an Australian ornithological puzzle – a second Night Parrot is found dead in Queensland. *Emu* 109: 198-203.
- McEvey, A.R. 1975. Victorian Ornithology – a chronology showing its characteristics. National Museum of Victoria, Melbourne.
- McGilp, J.N. 1931. *Geopsittacus occidentalis*, Night Parrot. *South Australian Ornithologist* 11: 68-70.
- McKean, J. L. 1959. A list of bird species recorded in Victoria. *The Bird Observer* Number 332 (July 1959): 2-4.
- Menkhorst, P. and Isles, A. 1981. The Night Parrot *Geopsittacus occidentalis*: evidence of its presence in north-western Victoria during the 1950s. *Emu* 81: 239-240.
- Murie, J. 1868. On the nocturnal Ground Parakeet (*Geopsittacus occidentalis*). *Proceedings of the Zoological Society, London*: 158-165.
- Murphy, S. 2013. Night Manoeuvres. *Australian Birdlife* 2(4): 20-22.
- Murphy, S. 2015. Shining a light: The research unlocking the secrets of the mysterious Night Parrot. *Australian Birdlife* 4(3): 30-35.
- North, A.J. 1898. List of birds collected by the Calvert Exploring Expedition in Western Australia. *Transactions of the Royal Society of South Australia* 22: 125-192.
- Pyke, G.H. and Ehrlich, P.R. 2014. Conservation and the holy grail: The story of the Night Parrot. *Pacific Conservation Biology* 20: 221-226.
- Robin, L. 2001. *The Flight of the Emu: a hundred years of Australian ornithology*. Melbourne University Press, Melbourne.
- Tarr, H.E. 1967. Bird list: Wyperfeld National Park. National Parks Authority, Melbourne.
- Taylor, P. 1996. *Karkarooc 1896-1995: A Mallee Shire History*. Yarriambiak Shire Council, Warracknabeal, Victoria.
- Wheeler, W.R. 1967. *A Handlist of the Birds of Victoria*. Victorian Ornithological Research Group, Melbourne.
- White, S.A. 1913. Field ornithology in South Australia: In the mallee. *Emu* 12: 179-185.
- Whittell, H.M. 1954. *The Literature of Australian Birds*. Paterson Brokensha Pty Ltd, Perth.
- Wilson, H. 1937. Notes on the Night Parrot, with references to recent occurrences. *Emu* 37: 79-87.



Figure 1. Portrait of Jowley published in 'Back to Hopetoun' (1935), original source unknown.

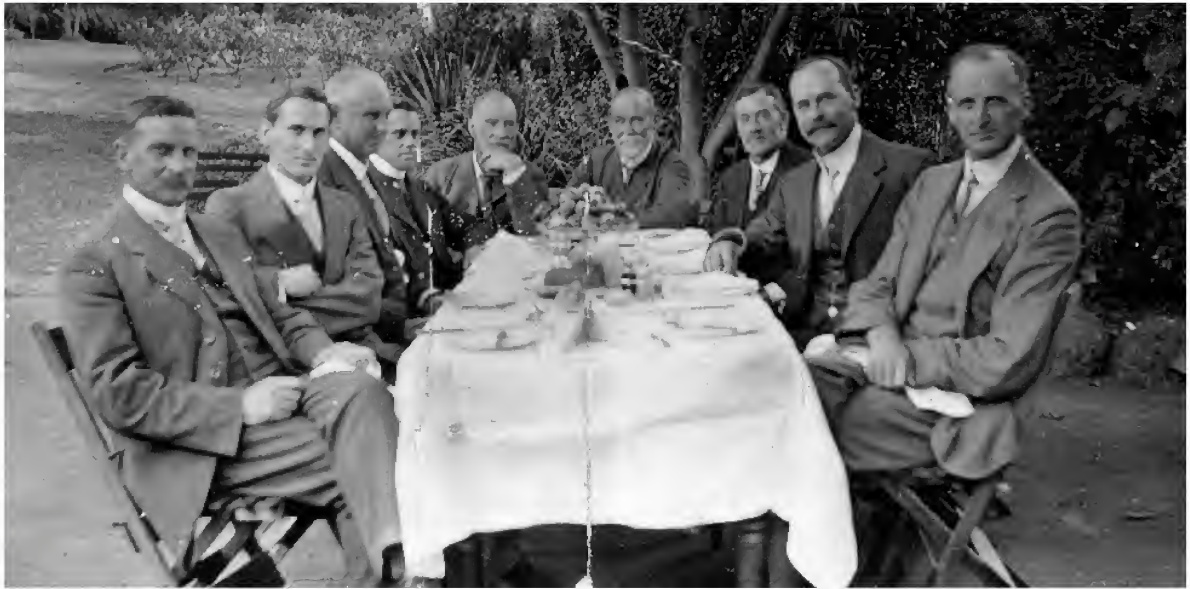


Figure 2. Participants at a reception held for Gregory Mathews by the 1914 RAOU Council at Melbourne's Royal Botanic Gardens on 10 March 1914. From left to right the participants are: Dr J. Leach, L. Chandler, C. McLennan, C. Barrett, A.J. Campbell, D. Le Souef, T. Tregellas, Z. Grey and G. Mathews.

